CITY OF CORVALLIS

STORMWATER MASTER PLAN

September 2002

CORVALLIS
ENHANCING COMMUNITY LIVABILITY

CORVALLIS STORMWATER MASTER PLAN

Adopted March 4, 2002 (Ord. #2002-06)

ACKNOWLEDGEMENTS:

Stormwater Master Plan Committee:[1]

Patricia Benner, **Chair**
Mary Buckman
Kelly Burnett
Mary Christian
Gary Galovich
Bob Grant
Stan Gregory
Wayne Huber
Fred Wright
Matthew Lehman
Hong Liner
Jim Minard
Paula Minear
Jim Moore
Douglas Parker
Ed Radke
Denise Ross
Greg Verret

Mayor: Helen Berg

Corvallis City Council:

Rob Gandara
Charles Tomlinson
Tony Howell
Karyle Butcher
Betty Griffiths
George Grosch
William Cohnstaedt
Hal Brauner
Stewart Wershow

Staff:

Jon Nelson, City Manager
Steve Rogers, Public Works Director
Eugene Braun, City Engineer
Ken Gibb, Community Dev. Director
Kelly Schlesener, Planning Manager
Bruce Moser, Project Manager
Fred Towne, Associate Planner
Tonya Fawver, Staff Assistant

Corvallis Planning Commission:

Mary Buckman
Gary Pond
Clay Higgins
Bill York
James Hackett
Denis White
Kirk Bailey
Bruce Osen
Jane Fleischbein
Rob Gandara (Council Liason)

---

[1] *The Stormwater Planning Committee (SWPC) was able to review and edit only Chapters 1 through 5 of the Stormwater Master Plan. The SWPC did not review the basin chapters or associated projects.*

ABBREVIATIONS

BMP	Best Management Practice
B&W	Barney and Worth
cfs	Cubic feet per second
COE	U.S. Army Corps of Engineers
CWA	Clean Water Act of 1977
DEQ	Oregon Department of Environmental Quality
DSL	Oregon Division of State Lands
EIA	Effective Impervious Area
ENR	Engineering News Record
EPA	U.S. Environmental Protection Agency
EQC	Oregon Environmental Quality Commission
ESA	Endangered Species Act of 1973
ESU	Evolutionarily Significant Unit
F	Fahrenheit
FEMA	Federal Emergency Management Agency
FIA	Federal Insurance Administration
FIRM	Flood Insurance Rate Map
FR	Federal Register
HCP	Habitat Conservation Plan
ITP	Incidental Take Permit
LCOG	Lane County Council of Governments
LID	Local Improvement District
MDOE	Maryland Department of the Environment
mg/L	Milligrams per liter
MIA	Mapped Impervious Area
mL	Milliliter
MRCI	Municipal, residential, commercial, and industrial
MS4	Municipal Separate Storm Sewer System
NAQWA	National Water Quality Assessment Program
NCSCC	North Carolina Sedimentation Control Commission
NEPA	National Environmental Policy Act
NFIP	National Flood Insurance Program
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
OAR	Oregon Administrative Rule
PFC	Properly Functioning Conditions
ODOT	Oregon Department of Transportation
PUD	Planned Unit Development
RUNOFF	Hydrologic model
SCS	U.S. Soil Conservation Service
SDC	System Development Charge
SDWA	Safe Drinking Water Act
SWMP	Stormwater Master Plan
SWPC	Stormwater Planning Committee
TM	Technical Memorandum
TMDL	Total Maximum Daily Load
UGB	Urban Growth Boundary
UIC	Underground Injection Control
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WPCF	Water Pollution Control Facility
WRD	Oregon Water Resources Department
WWTP	Wastewater Treatment Plant
XP-SWMM	EPA Stormwater Management Model, Hydrologic/hydraulic modeling package

GLOSSARY OF TERMS

Alluvial Stream – A stream that deposited the bed and bank materials of the channel perimeter under the present hydrologic regime. Alluvial streams have erodible boundaries and are free to adjust dimensions, shape, pattern, and gradient in response to change in slope, sediment supply or discharge.

Base Flood – Flood that has a 1 percent chance of occurring in any given year. This 100-year flood has been adopted by the Federal Emergency Management Agency (FEMA) for floodplain management purposes, and refers to a flood event that inundates the entire 100-year floodplain. (See "Floodplain, 100-Year" and "Flood, 100-Year.")

Beneficial Uses – The beneficial uses assigned by basin in the Oregon Administrative Rules for water quality and for Corvallis streams are as follows: public and private domestic water supplies, industrial water supplies, irrigation, livestock watering, anadromous fish passage, salmonids fish rearing and spawning, resident fish and aquatic life, wildlife and hunting, fishing, boating, water contact recreation, aesthetic quality, and hydropower, unless changed through a use attainability analysis.

Best Management Practices – Strategies for improving runoff water quality that are accepted throughout the industry. They include structural and non-structural measures to control pollutants at the source before they enter a stream. Structural BMPs include:

- Retention basins
- Detention basins
- Constructed wetlands
- Infiltration practices
- Filters
- Bioretention
- Biofilters (swales and filter strips)

Non-structural BMPs include:

- Street sweeping
- Illicit connection identification and elimination
- Public education and outreach
- Land use modifications to minimize the amount of impervious surface area
- Waste collection
- Proper materials storage

Bioswale – A constructed shallow, wide vegetated ditch through which storm runoff travels and that uses natural methods of cleaning water, such as sediment trapping and microorganism activity to remove pollutants.

City Limits – Boundary line that identifies land within the City.

Compatible – The ability of different uses to exist in harmony with each other. "Making uses compatible with each other" implies site development standards that regulate the impact of one use on another.

Corvallis Streams – All streams located either in part or entirely within the City's Urban Growth Boundary.

Density Transfer – Permits residential density under a single development application to be shifted from one part of a site and added to another part of the same site. It can be used to protect a wetland or other significant natural resource that is on the site without losing overall density in the development. Density transfer does not permit a net increase in density for the entire site, however it can specify that more intense residential building types are permitted within the area of the site that is to receive the density transfer.

Detention Basin – A constructed pond designed to temporarily collect runoff from a development to maintain the runoff rate to a specified pre-development flow.

Development – Making a material change in the use or appearance of a structure or land, dividing land into two or more parcels, changing the land use designation, or creating or terminating a right of access. Where appropriate to the context, development refers to the act of developing or the result of development.

Drainageway – Natural or artificial watercourse, including adjacent riparian vegetation, that transmits natural stream or stormwater runoff from a higher elevation to a lower elevation.

Drainageway Dedication – The transfer of ownership, in fee-simple, of a given piece of property for the purpose of stormwater functions.

Endangered Species – Any species in danger of extinction throughout all or a significant portion of its range.

Endangered Species Act – Federal regulatory program to protect fish, wildlife, and plants from extinction. It provides a means whereby the ecosystems upon which threatened and endangered species depend, may be conserved to ensure the continued survival of the species.

Enhance – Augment into a more desirable condition.

Erosion – Movement or displacement of soil resulting from natural and human-induced processes including weathering, dissolution, abrasion, corrosion, and transportation.

Flood, 100-year – A flood with a one percent chance of occurring in any given year. This is the flood most commonly used for regulatory purposes and is called the base flood. This flood event inundates the entire 100-year floodplain. (See "Base Flood.")

Floodplain – Area adjacent to a stream or a river channel that is covered by water when the river or stream overflows its banks.

Floodplain, 100-year – Area adjacent to a stream or river channel that includes land with a range of flooding frequency, from areas that flood frequently to the highest ground that has a one percent chance of flooding in any given year. The 100-year floodplain is the area subject to base flood regulations, and consists of the floodway and floodway fringe. (See "Base Flood" and "Flood, 100-Year.")

Floodplain Functions – Hydrological and ecological functions including temporary storage of floodwater, deposition of sediments outside of the channel, groundwater recharge, filtering of pollutants, and reduction of floodwater velocity and erosive forces. Also included, but to a lesser extent in previously urbanized areas, are such functions as nutrient exchange, refuges, and feeding areas for fish.

Floodway – River channel or other watercourse and the adjacent land areas that accommodate the base flood event without cumulatively increasing the water surface elevation more than 0.2 feet.

Floodway Fringe – Area of the 100-year floodplain lying outside of the floodway.

Flow-through Design – Typically a structure that does not hinder or obstruct the movement of, or displace, surface floodwater.

Hyetograph – A graph of rainfall intensity versus time.

Impact – The consequences of a course of action; the effect of a goal, guideline, plan, or decision.

Infill – Developing vacant and partially vacant land within a built environment. To be considered infill, such land shall be less than 0.5 acres in size for residentially designated lands or less than 1.0 acre in size for lands designated otherwise.

Intermittent Streams – An intermittent stream has flowing water during certain times of the year, when groundwater provides water for stream flow. During dry periods, intermittent streams may not have flowing water. Runoff from rainfall is a supplemental source of water for stream flow.

Key Areas of Exchange – Locations within a watershed where groundwater recharge from surface water occurs (e. g., permeable depressions) or where streams are fed by groundwater (e.g., springs).

Large Wood – The National Marine Fisheries Service defines large wood as 60 centimeters (24 inches) in diameter and at least 15 meters (49 feet) long. In the analysis of Corvallis' local streams done for the Endangered Species Act Salmon Listing Response Plan, large wood was identified as 10 centimeters (4 inches) in diameter and 3 meters (10 feet) long.

Maintain – Support, keep, and continue in an existing state or condition without decline.

Natural Swale – Naturally occurring linear depression that carries surface water only after rainfall. It also transports subsurface water seasonally or throughout the year.

NPDES – National Pollution Discharge Elimination System, which is the permitting system established by the Environmental Protection Agency to administer the Federal Clean Water Act.

Perennial Stream – A stream that has flowing water year-round during a typical year. The water table is located above the streambed for most of the year. Groundwater is the primary source of water for stream flow; runoff from rainfall is a supplemental source of water for stream flow.

Permeability – Ability of the soil to absorb water.

Policy – Decision-making guideline for actions to be taken in achieving goals and the community's vision.

Pre-existing Condition – Phrase used in the Stormwater Master Plan (SWMP) as a reference to the land characteristics and habitat condition prior to manmade modifications.

Preserve – Save from change or loss and reserve for a special purpose; the most strict non-degradation standard.

Pretreatment – Treatment of urban runoff prior to discharging into a public water body.

Properly Functioning Condition (PFC) – The National Marine Fisheries Service defines PFC as the sustained presence of natural habitat-forming processes that are necessary for the long-term survival of a species through the full range of environmental conditions.

Protect – Save or shield from loss, destruction, or injury or to save for future intended use. After "preserve," the next most strict non-degradation standard.

Redevelopment – Restoration or replacement of existing buildings.

Restoration – Process of returning an area to a close approximation of a former condition, and re-establishing functions.

Riparian – Land adjacent to a water body that directly affects or is affected by the aquatic environment. This includes streams, rivers, and lakes and their side channels, floodplains, and wetlands, and portions of adjacent slopes that shade the channel or provide streamside habitat. The area of transition from an aquatic ecosystem to a terrestrial system. (Note: This definition should replace the definition found in Article 50 of the Comprehensive Plan.)

Shall – Expressing what is mandatory.

Should – Expressing what is desired, but not mandatory.

Significant – A feature specifically identified as worthy of special recognition or protection (e.g., a "significant" wetland), or a resource that has been formally adopted by the City.

Stormwater – Rainfall or snowmelt that drains into public streams or pipes.

Stormwater Functions – Includes sustaining aquatic habitats, cleansing, nutrient transfer, and other beneficial functions.

Stormwater Phase II Rules – Federal Clean Water Act regulations that deal with runoff water quality issues, including pollutants and construction sediments. (See Appendix H for a summary of the Rules.)

Stream Corridor – Corridor of land of variable width along each side of a stream channel that is primarily reserved for stormwater-related and other stream system functions and processes.

Stream Corridor Functions – The attributes (uses and processes) connected with a stream corridor. These include ecological functions such as filtering pollutants, shading the channel, managing floodwater, supplying food for fish (insects, leaves, etc.) and other aquatic life, providing space for channel movement, and providing large wood to the channel when trees die.

Stream System – The channel, subsurface flow, and adjacent corridor, including the floodplain.

Sustainable – Able to be maintained or continued indefinitely.

Undeveloped Land in the Floodplain – Either (1) land that does not contain a primary structure or (2) in cases where land does contain a primary structure, then land that can be divided and the resulting vacant parcels can be developed per the Land Development Code.

Unwanted Species – Species that are either non-native or that do not contribute to the properly functioning condition of an adjacent stream.

Upland Natural Resources – Natural features and areas outside of the stream corridor and the 100-year floodplain that influence stormwater function and management. They include uplands, wetlands, vegetation, swales, and groundwater zones.

Urban Fringe – Area within the Urban Growth Boundary and outside the city limits.

Urban Growth Boundary – A line that circumscribes the urban fringe and the city limits and that is intended by state and local regulations to contain the area available to urban development.

Urban Stream – Seasonally or perennially surface-flowing watercourse with a defined channel, including watercourses in either a native or altered form.

Watershed – Drainage area of a specific stream system. Small watersheds are components of larger watersheds.

TABLE OF CONTENTS

LIST OF FIGURES

(an * indicates figure follows page listed)

LIST OF FIGURES

(an * indicates figure follows page listed)

LIST OF TABLES

EXECUTIVE SUMMARY

The City of Corvallis (City) worked with a 13-member Stormwater Planning Committee (SWPC) to develop the *City of Corvallis Stormwater Master Plan* (SWMP). The committee members were appointed by the Mayor and met over a 5-year period to support preparation of the plan. The SWMP makes recommendations to improve water quality, address existing and future flooding problems, and protect or enhance natural systems, including riparian, stream, and floodplain functions. It is intended to guide upgrades and expansion of the stormwater conveyance system and to guide stormwater management within the City over the next 20 years.

The recommendations will affect the City's capital improvement and operating programs. Stormwater utility rates and system development charges will need to be updated to finance the recommendations of the SWMP. Other recommendations include new City policy and development standards that will affect the way future development manages stormwater and the associated natural resources.

The SWMP's study area is defined by the natural drainage basins or watersheds that constitute the area's drainage system. The study area crosses City boundaries and extends into, and in some locations, beyond, the current Urban Growth Boundary, which represents the potential future boundary of the City, as shown in Figure ES-1. Recommended improvements for areas outside the current city limits will not be implemented until those areas are incorporated into the City or until a cooperative agreement is reached with Benton County.

The City and the technical consultant team worked closely with citizens, the SWPC, Benton County, and relevant regulatory agencies to develop the SWMP. Implementation of the SWMP will require active involvement of property owners, all City departments, state and federal agencies, and local stakeholders.

PUBLIC INVOLVEMENT

Implementation of the SWMP requires community support to be successful. A comprehensive public involvement program was included in the planning process to ensure that the SWMP addressed community values and concerns. The public involvement program included the following elements:

> An **SWPC** to provide ongoing review, guidance, and liaison with the community. SWPC members were appointed by the Mayor to represent a broad range of community interests. They played an integral role in each aspect of the planning process.
>
> **Interviews with community leaders and key stakeholders** to establish a baseline of public opinion and identify public sentiment toward the management of stormwater in the City. Fifty stakeholders representing a wide spectrum of the community participated in the survey, including landowners, business owners, residents, neighborhood and community organizations, local government representatives, state government representatives, Oregon State University representatives, Planning Commissioners, and City Councilors.

Public telephone surveys to solicit input from local residents.

Public workshops to solicit community input into the planning process, including two general meetings to identify public values, one meeting to finalize evaluation criteria, and two follow-up meetings to present stormwater recommendations to the public.

Workshops/meetings held for each group of watersheds to solicit input from local residents regarding problems, concerns, and their visions for the future. The workshops and meetings also served as a way to share with local residents the preliminary results of the modeling and alternatives development tasks. The eight watersheds were divided into three groups to facilitate meeting preparation and execution.

OBJECTIVES

Objectives were identified to guide the stormwater planning process based on seven categories of issues identified by the SWPC and the City. The issues to be addressed by the SWMP include:

- Stormwater quality
- Stormwater quantity
- Uplands and wetlands natural resources
- Floodplain
- Stream system
- Public participation and information outreach
- Cross-jurisdictional stormwater management

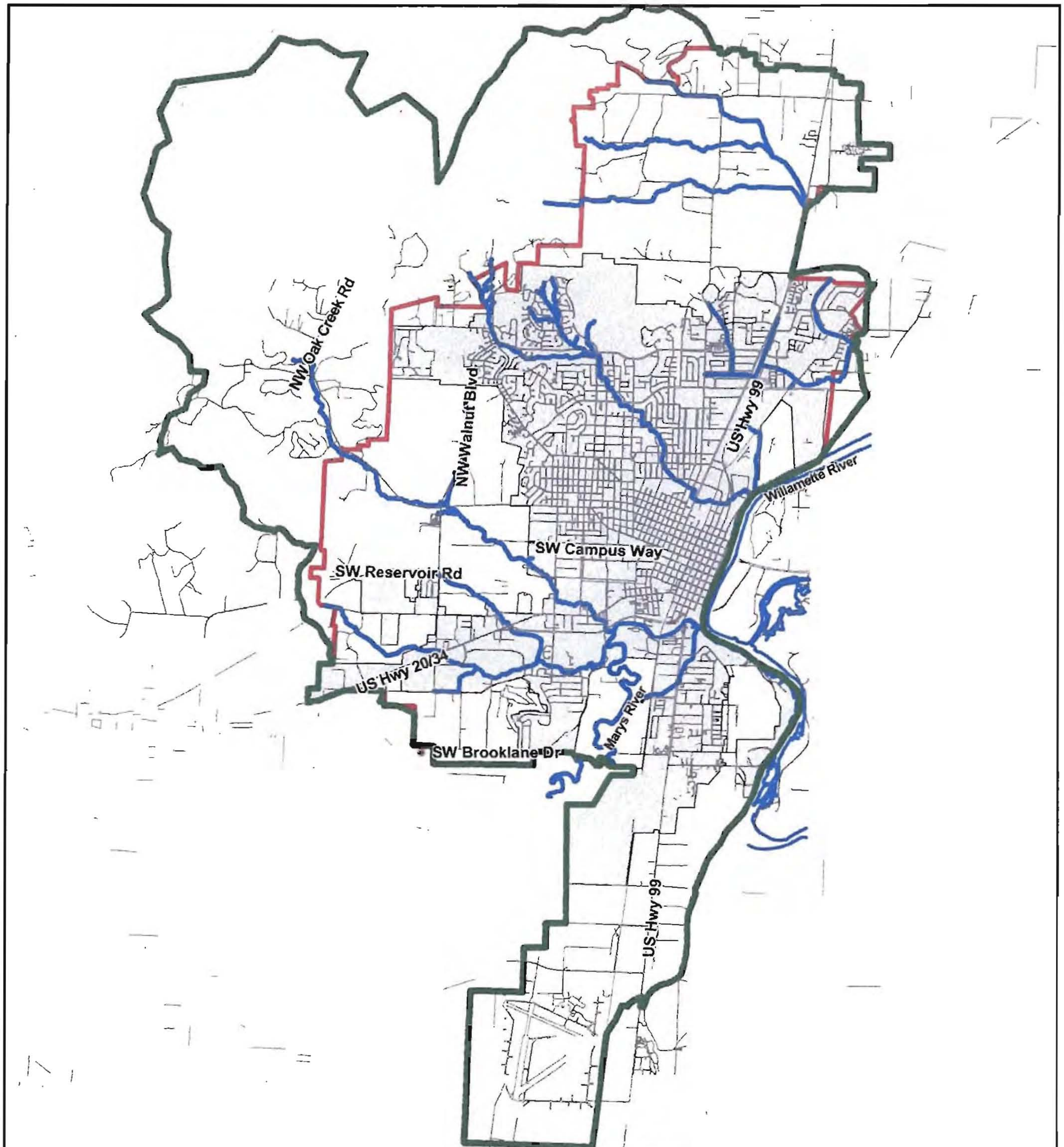
In addition, City policies were developed to support the objectives identified for each of the issues.

THE PLANNING PROCESS

The development of the SWMP involved a number of activities spanning multiple disciplines. The following activities were performed:

Description of planning area characteristics including topography, geology and soils, vegetation, climate, rainfall statistics, and land use. These factors play an important role in determining the quantity and quality of stormwater discharges.

Stream channel assessments of selected stream reaches to determine existing channel and bank conditions.



LEGEND

Urban Growth Boundary

City Limits

Study Area

N

Figure ES-1 Study Area

CORVALLIS

Public Works Department

BROWN AND CALDWELL

and Associated Firms

report/figu... /FigES-1.wor, December 8, 2000, base data from City of Corvallis GIS Department

Hydrologic/hydraulic modeling to analyze flows from existing and projected future (build-out) conditions. The hydrologic models determined the quantity of stormwater runoff to be conveyed by the manmade and natural conveyance systems. The hydraulic models determined whether the capacity of the existing conveyance system was adequate for the modeled conditions.

Regulatory review to identify state and federal regulations affecting stormwater and natural resource management.

Development standards review and recommendations to provide water quality treatment and detention of stormwater runoff for new development.

Alternatives development and analysis to address system deficiencies, based on the modeling results and on input from the public and City staff. Alternatives were generated based on the evaluation criteria developed by the SWPC.

Watershed recommendations to address the specific needs of each of the watersheds. Recommendations include specific projects, operation and maintenance requirements, and citywide measures that are addressed through the development of new City policy.

Implementation plan to prioritize implementation of recommended activities. The SWPC and City established two levels of prioritization: Short-Term and Long-Term Programs. The implementation plan identifies the cost of the capital improvements and maintenance recommendations.

The SWPC developed the following evaluation criteria to guide the development of the new SWMP:

- Maintains and accommodates natural hydrological processes.
- Protects and improves water quality.
- Protects and restores natural resources and ecosystem functions.
- Controls unwanted erosion.
- Meets current regulations and anticipated future regulations.
- Implements urban and rural land use objectives.
- Minimizes maintenance requirements and allows for maintenance access.
- Is designed and managed to avoid public health and safety hazards.
- Ensures that cost considerations are inclusive.
- Addresses cumulative impacts and off-site impacts.
- Explores and uses innovative and low-technology approaches.
- Incorporates community awareness.

The SWMP integrates the broader watershed and its functional elements and processes into stormwater planning and implementation. Streams that were viewed solely as water conveyance systems are seen as an integral part of the community's ecological health. Watershed planning is intended to provide a unified stormwater management strategy that will address water quality, water quantity, uplands natural resource and wetlands management, floodplain and stream-system management, and cross-jurisdictional basin management.

RECOMMENDED IMPROVEMENTS

The SWMP recommends a capital improvement program based on two levels. Projects are prioritized into either the short-term or long-term program. The short-term program is anticipated to be implemented over a 10-year period, followed by the long-term program. The implementation schedule for projects within each program is subject to a number of factors that requires annual evaluation of the priority ranking. City staff will ensure that the implementation schedule satisfies the needs of the community within the constraints of available funding.

Nearly $7 million in capital projects is recommended for the short-term program. The long-term program identifies approximately another $4 million in capital expenditures for a total stormwater capital program of approximately $11 million. Capital costs for both programs are listed in Table ES-1.

Table ES-1. Total Capital Cost of Recommendations

Activity	Short-Term Program ($)	Long-Term Program ($)	Total
Capital Fund			
Capital projects	$6,644,000	$4,416,000	$11,060,000

The short-term and long-term programs also define operation and maintenance costs. Table ES-2 lists the estimated costs for both programs.

Table ES-2. Total Operating Cost of Recommendations

Activity	Short-Term Program ($/year)	Long-Term Program ($/year)	Total
Operating Fund			
Operations and maintenance	180,100	164,000	344,100

FUNDING

The City has a stormwater utility for funding capital, operational, and maintenance activities. The monthly rates and system development charges will be re-evaluated as necessary to reflect the recommendations of the SWMP. Based on preliminary calculations, the monthly rate for funding the short-term program will be similar to charges levied by other major cities within western Oregon.

CITY POLICY

New policies were developed to address the issues identified by the SWPC and the City. Adoption of this SWMP includes the adoption of its new policy recommendations. The policies will augment existing City policy outlined in the Comprehensive Plan.

OTHER PLANNING DOCUMENT RECOMMENDATIONS

Several modifications to the Design Criteria Manual were recommended to address stormwater run-off quantity and quality issues. Additional planning document modifications will be required to support the new policies defined by the SWMP. The City will need to review the Municipal Code, Land Development Code, Design Criteria Manual, and Standard Construction Specifications to determine modifications required to support the SWMP. The City will also need to address new regulatory requirements, including the Endangered Species Act, National Pollutant Discharge Elimination System Phase II, Total Maximum Daily Loads, and the National Flood Insurance Program.

RECOMMENDATIONS

The City should initiate the following activities to support the SWMP:

- Conduct a rate study to update the City's stormwater rate structure
- Update other planning documents to support the SWMP and meet new regulations

CHAPTER 1

INTRODUCTION

1.0 VISION

The vision for the Stormwater Master Plan (SWMP) is an outgrowth of the Corvallis 2020 Vision Statement. Its purpose is to paint a picture for how stormwater will be addressed in the future.

We value our rivers, streams, and watersheds, carefully managing them to protect the purity of our water, their aesthetic and biological qualities, and their value as recreational areas. The City's streams and wetlands act as the backbone for a system of "green fingers" that weave through and connect the City's open space resources. These "green fingers" provide habitat corridors where native plants and wildlife flourish in their natural state. These "green fingers" widen out at community parks and open space preserves to provide additional storage capacity for flooding events.

Our natural open space helps buffer flood events, purify our air and water, provide recreational and educational opportunities, and reinforce the community's distinctive character. Corvallis has identified its open space resources, and has established criteria and priorities for open space protection. Natural flooding is encouraged, while urban flooding is managed through detention, enhanced stream capacity, and additional forest cover.

The community's water supply, streams, and creeks are clean and clear. Water conservation efforts decrease the amount of water City residents consume. Drinking water quality has been improved by convincing upstream entities to stop polluting the Willamette and its tributaries. Runoff from roads and other pollution sources is collected and treated before being discharged. We guard our precious water sources closely, by exercising extreme care in disposing of hazardous wastes, and we closely follow state and federal environmental regulations.

Pollution obeys no human boundaries. Recognizing that, the City coordinates its water quality efforts with other communities, surrounding counties, and resource management agencies in the Willamette Valley. This cooperative strategy has created a cleaner, healthier environment by encouraging improved farming and forestry techniques. Oregon State University and valley ranchers have helped improve stream water quality through better animal management practices and waste disposal methods.

The City provides leadership by managing each of its watersheds to accommodate natural hydrological processes. This is achieved through innovative low-technology approaches to watershed management. The City maintains stream functions within the urban areas while achieving compact urban form. Land use regulations for both urban and rural development ensure that stream functions are preserved and in some cases enhanced. Developers are informed of the implications associated with soil erosion during construction, and take special precautions to control unwanted erosion. The City has taken steps to protect and restore natural habitats, which have improved ecosystem functions. The City has developed implementation measures to ensure that long-term costs associated with new stormwater measures will benefit future generations.

Property owners adjacent to streams take an active role in maintaining and enhancing streamside property. This has been accomplished through an ongoing educational campaign that has heightened community awareness of natural stream functions.

1.1 INTRODUCTION

The City's SWMP recommends policies, activities, and programs formulated to improve water quality, address existing and future conflicts between flooding and development, and preserve and enhance valuable natural resources, including stream and floodplain systems. The recommendations will directly affect the City's capital improvement and operating programs. In addition, new policies and development standards have been recommended that will affect the way future development is conducted within the area. Implementation of the SWMP will require the active involvement and cooperation of all property owners, City departments, and State and federal agencies.

1.2 AUTHORIZATION AND PURPOSE

In December 1997, the City began developing an updated SWMP for guiding upgrades and expansion of the stormwater system to meet the area's needs over the next 20 years. The SWMP provides recommendations to address existing system deficiencies, projected growth-related requirements, and the requirements of State and federal regulations. The capital and operating costs for implementing project recommendations are identified.

1.3 BACKGROUND

The SWMP addresses the management of stormwater and natural stream systems within the study area illustrated in Figure 4-1. The study area extends beyond the City boundary and, in some places, outside of the current Urban Growth Boundary (UGB). The study area includes the entire drainage basin that contributes flow to each of the streams that pass through the City. This watershed-based approach to stormwater management provides a perspective for addressing all of the needs of each stream system and for including all of the stakeholders in the planning and implementation process. Stakeholders include the citizens living within the watershed, private and public property owners, the City, Benton County, and OSU.

1.3.1 Historical Drainage Management

The surface water drainage system has developed as one of the necessary components of infrastructure required to support City growth and vitality. Throughout the City's history, the drainage system has been constructed to convey surface runoff, to drain low areas as part of new development, and to prevent flooding. Water quality and natural resource protection objectives were not a part of early development activities. The area's streams were used, and continue to be used, as receiving points for local stormwater drainage.

Urbanization and past stormwater management practices have taken a toll on the City's streams, wetlands, and riparian areas. Increased development has increased the quantity of impervious areas, which directly affects stormwater runoff volumes and velocities. Increased stormwater runoff and higher velocities have upset the natural equilibrium of the stream, resulting in streambed and stream-bank erosion that is evident throughout the City. In addition, development tends to decrease the width of riparian and upland areas adjacent to streams. Loss of these natural areas reduces water quality, increases runoff rates, and decreases biological diversity. In general, urbanization negatively impacts the stream, riparian, wetland, and upland ecosystem. Chapter 4 provides a more in-depth discussion on the impacts of urbanization.

1.3.2 Previous Plans

Several planning documents have been previously developed to assist the City with its stormwater management:

- *Corvallis Drainage Master Plan*, CH2M Hill, May 1981
- *Dixon Creek Flood Reduction Analysis*, KCM, December 1997
- *South Corvallis Drainage Master Plan*, KCM, December 1998

The *Corvallis Drainage Master Plan*, completed in May 1981, formed the basis of the City's stormwater management for the next 20 years. Its focus was to develop infrastructure for the safe conveyance of stormwater flows. Water quality and natural resources were not addressed.

The *Dixon Creek Flood Reduction Analysis* addresses the specific needs of Dixon Creek. Frequent flooding along this stream, and in particular, the severe storm events of February and November 1996, threatened private property and the safety of local residents. In response, the City initiated the analysis to identify flood control measures for Dixon Creek. The analysis recommends 11 projects to address flooding, several of which have been implemented.

The *South Corvallis Drainage Master Plan* (SCDMP) was developed in 1996 and approved by the City in December 1998. The SCDMP addresses stormwater drainage issues in the southern portions of Corvallis that hinder development of vacant lands in the area. The SWMP augments the recommendations proposed by the SCDMP through measures that will affect stormwater management throughout the City.

1.3.3 Existing Stormwater Financing

In 1978, the City Council approved an ordinance establishing a stormwater utility. The utility was formed to fund capital improvements and activities as required for managing the City's stormwater conveyance system. In general, funds are generated by monthly fees to the utility users and by one-time System Development Charges (SDCs) for new construction. The funds generated by the monthly fees are used to address existing system deficiencies and to operate and maintain the conveyance system. Unlike the monthly fees, the SDCs are used to address extra-capacity or growth-related stormwater improvements.

In fiscal year 99-00, monthly fees generated approximately $1.5 million in revenue for funding stormwater related activities and improvements. Approximately 13,600 accounts (customers) contribute to the stormwater fund with rates based on equivalent surface units (ESUs). An ESU represents approximately 2,750 square feet of impervious surfaces. A monthly charge is levied against each ESU; in fiscal year 99-00 the charge was $4.23.

A citywide study in 1999 updated the SDCs. The charges will be updated again to include the funding recommendations of the SWMP. SDCs are an important component of the stormwater fund with approximately $44,000 added to the fund in fiscal year 99-00. In 2001, the storm drainage component of the SDC was calculated based on $0.0306 per square feet of impervious surface. For a 2,600 square foot single-family residence, this is equal to a one-time charge of $79.56.

1.4 SWMP OBJECTIVES

Early in the development of the SWMP, the City and the citizen-based Stormwater Planning Committee (SWPC) identified watershed-related management issues that needed to be addressed in the SWMP. Each issue constitutes an element of the overall watershed approach that forms the basis for the SWMP:

- Stormwater quality
- Stormwater quantity
- Uplands and wetlands natural resources
- Floodplain
- Stream system
- Public participation and information outreach
- Cross-jurisdictional stormwater management

The City and the SWPC identified objectives for each issue identified above. The overall management strategy focuses on achieving these objectives. Chapter 5 describes the objectives and the policies that were developed for addressing the issues.

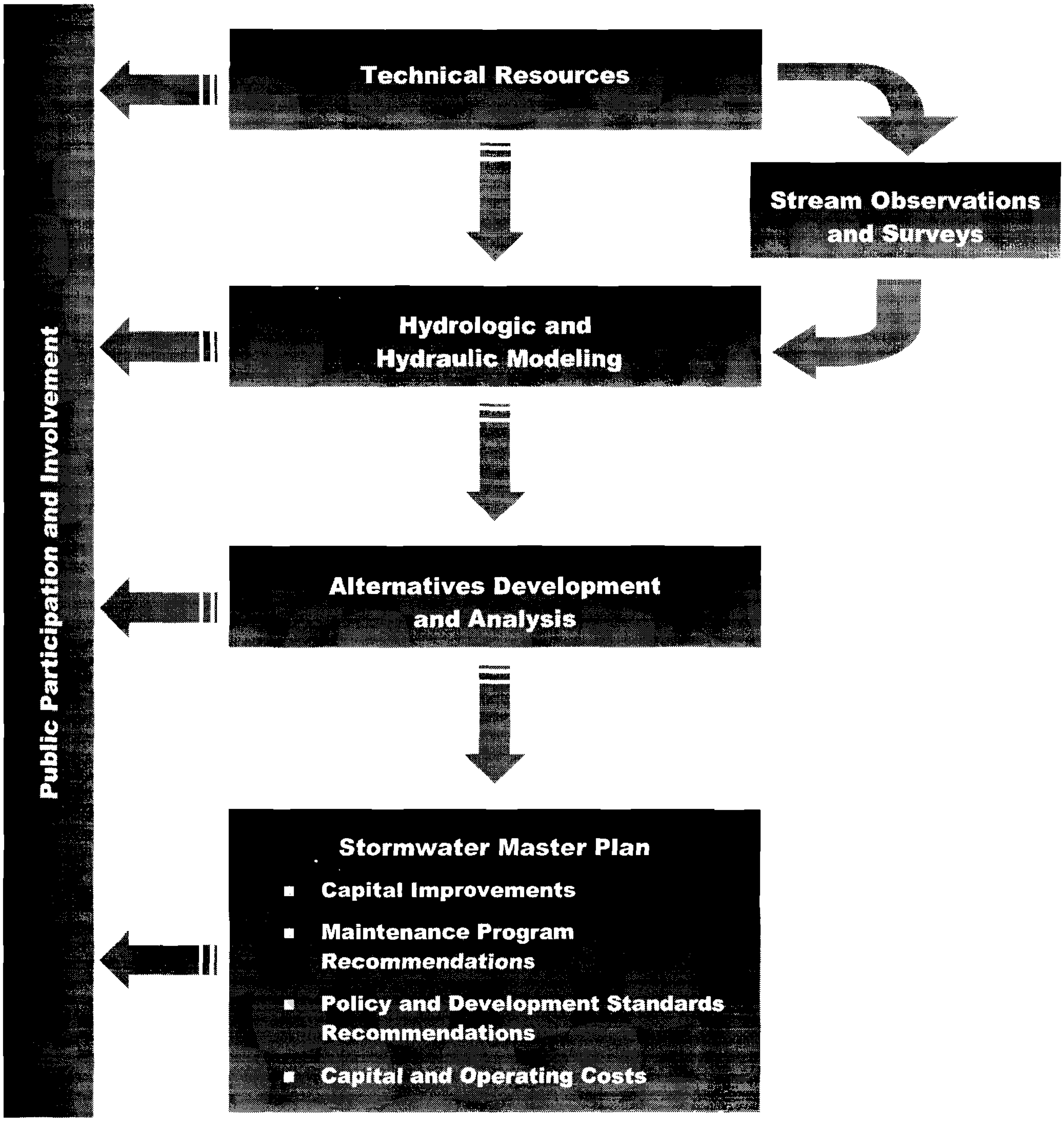
1.5 DEVELOPMENT PROCESS OF THE SWMP

The following tasks were required to be completed prior to the preparation of the SWMP.

- Public involvement process
- Field investigations
- Modeling and technical studies
- Identification of problem areas and opportunities
- Alternatives development
- Policy recommendation
- Capital improvement recommendation

Figure 1-1 shows the sequence of major tasks for developing the SWMP and the involvement of the public process.

Figure 1-1. Activity Flowchart



1.5.1 Public Involvement Process

The community's input and involvement during the planning process was of paramount importance to the City. The Mayor began the process by appointing the Stormwater Planning Committee (SWPC), as established by the City Council. The SWPC was to be involved with developing the community outreach program, participating in the selection of the consultant team, developing decision criteria for evaluation of options, overseeing technical work required for the plan, preparing draft and final plans, and making recommendations to the Council. The SWPC took a lead role in public outreach, including collecting citizen comments, identifying key public objectives and values to guide the planning, contributing to the selection and design of communications tools, facilitating public forums, and weighing the results of citizen feedback. In addition, the SWPC participated in the review and development of Chapters 1-5 of the SWMP and the development of policy recommendations.

Chapter 2 provides a detailed description of the public involvement process. The results of public meetings and surveys are summarized in Appendix A.

1.5.2 Collection and Development of Technical Resources

The recommendations provided by this SWMP are based in part on the physical characteristics of the City and surrounding study area. Information on rainfall quantity, intensity, and duration; soils; geology; topography; creek and storm conveyance system; land-use; and other physical factors were provided by the City or were obtained from other public-domain sources.

In addition, development of the SWMP involved conducting a field assessment of the existing channel and bank conditions at selected locations in each basin within the UGB. Locations were selected based on input from the SWPC and City staff, and a review of aerial photographs, maps, and information provided by the City (e.g., complaint and maintenance records). The first objective of the assessment was to characterize the general condition of the streams by noting items such as channel geometry, bank and bed stability, general floodplain functionality, vegetation and canopy, instream habitat, erosion and deposition, and accessibility for construction and maintenance.

Areas that presented opportunities for both immediate and long-term urban stream restoration, early action, and stewardship projects were also documented in the field notes from the stream observations. The City and SWPC were to consider applicable early action projects to be implemented while the SWMP was under development. Projects that might impact downstream conditions or that might have a large financial impact on the City were deferred for consideration and addressed during the development of the watershed plans found in Chapters 6 through 13.

Detailed results of the field investigations are available in Appendix B.

1.5.3 Modeling and Technical Studies

Models of the existing and future hydrologic conditions were constructed, tested, and run for each stormwater basin. The modeling addressed the main-stem open drainage and piped components of the stormwater system within the UGB. The existing land use was based in part upon review of digitized aerial photographs made available by City staff at the start of the project. Future scenarios were modeled using the full-buildout future land use condition, provided for in the City's Comprehensive Plan. Additionally, photogrammetric information from the City's geographical information system was used to estimate imperviousness for existing land uses. The models were used to identify problem areas and to provide an analysis tool during the alternatives analysis phase.

Technical Memorandum No. 1 in Appendix C summarizes the modeling process and lists the results of the modeling.

1.5.4 Alternatives Analysis

The alternatives analysis included analyzing the results of the public involvement, field investigation, and modeling tasks. It identified problem areas and proposed potential solutions. The City and the SWPC were involved during this stage to assist in crafting solutions that reflected the goals and values of the community.

1.5.5 The Plan

The City's existing stormwater planning documents are in need of significant review and updating to provide the necessary foundation for decisions related to the stormwater system and to future land use and development. The SWMP outlines the development of a new master plan for the planning, management, engineering, development, and regulation aspects of the City's stormwater utility for all areas within the Corvallis UGB. The new master plan incorporates environmental restoration and protection of the natural components of the stormwater utility.

The SWPC created the following evaluation criteria list that was used to guide the development of the new master plan.

- Maintains and accommodates natural hydrological processes.
- Protects and improves water quality.
- Protects and restores natural resources and ecosystem functions.
- Controls unwanted erosion.
- Meets current regulations and anticipated future regulations.
- Implements urban and rural land use objectives.
- Minimizes maintenance requirements and allows for maintenance access.
- Is designed and managed to avoid public health and safety hazards.
- Ensures that cost considerations are inclusive.
- Addresses cumulative impacts and off-site impacts.
- Explores and uses innovative and low technology approaches.
- Incorporates community awareness.

The SWMP integrates the broader watershed and its functional elements and processes into stormwater planning and implementation. Streams that were once viewed solely as water conveyance systems are seen as an integral part of the community's ecological health. Watershed planning is intended to provide a unified stormwater management strategy that will address water quality, water quantity, uplands natural resource and wetlands management, floodplain and stream-system management, and cross-jurisdictional basin management.

1.6 ORGANIZATION OF THE SWMP

The SWMP is organized as follows:

Executive Summary - Provides a brief summary of the SWMP in the form of a final project transmittal letter.

Chapter 1: Introduction - Describes the authorization and purpose, background, objectives, and processes for developing the SWMP.

Chapter 2: Public Involvement - Describes the major elements of the public involvement and outreach processes along with a summary of the results.

Chapter 3: Basis of Planning - Describes the basis for hydrologic and hydraulic modeling, the engineering standards to be used in developing alternatives, methods for estimating project costs, strategies used for developing improvement programs, and a summary of the regulations impacting the SWMP.

Chapter 4: Study Area Characteristics - Describes the physical characteristics of the study area, including geography, land use, geology, soils, climate, rainfall, and a description of the conveyance system.

Chapter 5: Community-Wide Stormwater Planning and Policies - Summarizes the existing planning framework and presents recommended policies for addressing the major issues that impact stormwater management within the City.

Chapters 6 - 13: Watershed Planning and Analysis - Describes the physical characteristics of the following watersheds, summarizes the major findings from the public process, documents City experience in the area, presents deficiencies in the conveyance system as identified by modeling, identifies problem areas, and recommends projects and activities to address deficiencies and to protect water quality, the creek, and natural resources in the area.

Chapter 6: Dixon Creek

Chapter 7: Squaw Creek

Chapter 8: Jackson/Frazier/Village Green Creeks

Chapter 9: Sequoia Creek

Chapter 10: Garfield Basin

Chapter 11: Oak Creek

Chapter 12: Marys River

Chapter 13: South Corvallis

Chapter 14: Implementation Plan - Summarizes the recommendations from all of the watershed chapters in terms of cost for the short- and long-term programs, identifies capital improvement and operating program costs, and discusses the next steps required for funding the SWMP.

Technical Appendices - Presents background and detailed information on the project, including stormwater-related regulations, public involvement process, summary of the streamwalk observations, a technical memorandum on the hydrologic/hydraulic modeling, technical memorandum describing the basis of costs, and other related information.

CHAPTER 2

PUBLIC INVOLVEMENT

Public involvement is an important component of a successful planning process. This chapter describes the public involvement process for the Stormwater Master Plan (SWMP). The objectives of the public involvement process are discussed, as are the use of public surveys, public meetings, and incorporation of public concerns into the evaluation criteria.

2.1 OBJECTIVES AND GOALS

The City of Corvallis' (City) goal was to begin public involvement in the first days of the project and continue through plan adoption and implementation. The City Council directed the Mayor to appoint the Stormwater Planning Committee (SWPC) to facilitate and guide the public process required for the SWMP. The SWPC was selected to represent a cross-section of stakeholders in Corvallis, including citizens-at-large, whose task was to provide input into the development of a master plan to address existing and potential future stormwater issues in Corvallis.

The City designated the SWPC to lead implementation of the public involvement plan. The SWPC listened to citizens, identified key public values to guide planning, contributed to the selection and design of communication tools, participated in public meetings, and weighed the results of citizen feedback. As part of this responsibility, the SWPC met approximately every other week throughout the length of the project.

2.2 RESULTS FROM THE SURVEYS

At the beginning of the project, a public involvement consultant conducted a telephone survey of Corvallis residents. The survey served to "provide guidance to the Stormwater Planning Committee around public opinion and identify public sentiment toward the management of stormwater in Corvallis." Its purpose was to solicit input from the broader community affected by stormwater planning who might not typically participate in a public process to voice opinions and concerns.

The telephone survey was conducted in late December 1997 and early January 1998. A total of 366 residents responded to the survey. The results are consolidated into four basic thoughts:

- While residents generally lacked knowledge of the specifics of their stormwater service, they recognized the importance of the public safety and environmental impacts of stormwater management.

- Development was not seen as necessarily negative, but was recognized as impacting stormwater issues.

- Due to its impacts, development should help finance improvements and enhancements to the City's stormwater system.
- Residents acknowledged that while system development charges should pay for upfront costs, they are willing to accept responsibility for ongoing maintenance costs.

Details of the telephone survey are in Appendix A.

In addition to the telephone survey, lengthier interviews were held with community leaders and key stakeholders. Fifty participants were asked to share their views related to stormwater issues, the nature and severity of flooding problems, causes and possible solutions to flooding, values and principles to guide decision making, costs, and means for citizen participation. Among the persons interviewed were representatives of Corvallis neighborhood associations, environmental/clean water advocates, developers and homebuilders, business community leaders and employers, regulatory/resource agency personnel, members of the City Council, and area residents and property owners in affected watersheds. The key points offered by the stakeholders are:

1. Flooding is not the main problem.
2. Solutions must be site-specific.
3. Multiple-benefit and "natural" solutions are preferred.
4. A basin-by-basin approach to stormwater planning is necessary.
5. Public agencies should set a good stewardship example.
6. Existing ratepayers and new development should equitably share costs of stormwater system improvements.
7. The best methods of public outreach target lay citizens.
8. Gaining broad-based citizen understanding of stormwater issues will require a long-term commitment to public education.
9. The stormwater master plan should provide solid guidance for managing stormwater while maintaining and enhancing livability.

Additional discussion of the stakeholder survey is in Chapter 5. The full results are included in Appendix A.

2.3 PUBLIC MEETING FEEDBACK

A number of public meetings were held during the course of the project to distribute information about watershed planning efforts and to solicit input. A public project kickoff meeting was held on May 28, 1998. A subsequent public meeting on July 7, 1998, centered on identifying public values and, on December 3, 1998, a third public meeting was held to finalize public values and develop evaluation criteria.

Following the general public meetings, additional public meetings were held for each group of watersheds in the UGB. Two meetings were held for each group at a location within one of the watersheds to solicit input from local residents and interested citizens about problems, concerns, and their visions for the future. Preliminary results were also shared with the public at these meetings. Table 2-1 lists the watershed meeting dates.

Table 2-1. Public Meetings for Watershed Groups

Watershed Group	First meeting	Second meeting
Dixon Creek	March 30, 1999	April 6, 1999
Squaw Creek	March 30, 1999	April 8, 1999
Jackson Creek, Frazier Creek, Village Green Creek, Sequoia Creek, & Garfield Drainage	June 15, 1999	July 20, 1999
Oak Creek, Marys River, & South Corvallis	June 19, 1999	September 30, 1999

Feedback from the public varied from general comments about the watershed planning process to specific comments about local problems. The comments were recorded at each meeting and incorporated into the appropriate chapters of the SWMP. Each watershed chapter (chapters 6 through 13) lists the general public remarks pertinent to that watershed, and lists site-specific remarks in the relevant stream reach section. Public remarks were minimally edited to preserve the context. All of the remarks recorded in the public meetings listed in Table 2-1 are in Appendix A.

Public comments were used in several ways during the course of this project. The comments served to alert the project team to problems and concerns that may not have shown up in City staff reports, field investigations, or modeling; they confirmed problems and concerns noted by the other sources; and they helped formulate the public's vision for the future, which influenced the choice of alternatives for each watershed.

2.4 EVALUATION CRITERIA

The SWPC identified the evaluation criteria to be used in the formulation of the SWMP based on important issues expressed by members of the public. Participants reviewed the draft criteria during public meetings before it was finalized. The final criteria for the master planning process are:

- Maintains and accommodates natural hydrological processes.
- Protects and improves water quality.
- Controls unwanted erosion.
- Protects and restores natural resources and ecosystem functions.
- Meets or exceeds current regulations and anticipated future regulations.

- Ensures that cost considerations are inclusive.
- Addresses maintenance requirements and allows for maintenance access.
- Incorporates community awareness and information exchange.
- Addresses cumulative impacts and off-site impacts.
- Is designed and managed to avoid public health and safety hazards.
- Incorporates community amenities.
- Explores and uses innovative and low-technology approaches.
- Implements urban and rural land use objectives.

The final criteria were presented to the public in the Stormwater Alternatives Workshop on March 16, 2000. At the workshop, the public worked in small groups to rank the importance of the evaluation criteria. The results were used to recommend changes to the City's Comprehensive Plan and to help formulate appropriate projects and activities for each of the watersheds. Further explanation of the criteria is in Appendix A.

2.5 PUBLIC MEETINGS TO REVIEW THE DRAFT PLAN

The SWPC, in conjunction with the City Council Urban Services Committee, hosted two public meetings on August 14 and August 16, 2001, to collect comments on a complete draft of the SWMP. Before final adoption, the Corvallis Planning Commission and the City Council conducted public hearings to consider public comments relevant to the Plan.

CHAPTER 3

BASIS OF PLANNING

The stormwater master planning process used available physical and scientific information, and included a number of assumptions. This chapter describes the information and assumptions that formed the basis of planning for the Corvallis Stormwater Master Plan (SWMP), including the timeframe for the project, level of service provided, engineering standards, modeling parameters, methods for estimating costs, implementation strategies, and related regulations. The basis of planning provides a reference point from which to evaluate the results and recommendations, and for updating the plan in the future.

3.1 TIME FRAME FOR ANALYSIS

In the fall of 1997, the City of Corvallis (City) contracted with Brown and Caldwell to assist in developing the SWMP. The most current information was used to construct the models and perform the analyses.

The City provided mapping (e.g., streets, tax lots, streams, water bodies, and other major features) from its Geographic Information System. Lane County Council of Governments (LCOG) provided information on land use based on 1999 information. LCOG was under contract with the City Planning Department to update land-use maps for the City's *Draft Corvallis Comprehensive Plan* (1998). Photogrammetric coverage with 2-foot contour increments from 1998 was used to define the topography of the study area. Information on the collection system (e.g., pipe diameters, invert elevations, depth of cover, and channel geometry) was provided by the City over the course of the project. City survey crews collected field data as necessary. The consultant team collected other data during stream walks or other field investigations.

3.2 LEVEL OF SERVICE

The City's *Design Criteria Manual for Public Improvements* (July 1991) specifies a "10-year design storm" for sizing storm drains. In general, this pertains to a collection system designed to convey storm flow that is expected to occur approximately once every 10 years. The 10-year design storm was used to size pipes, culverts, and bridges modeled by this planning effort. Other design storms were modeled, including the 2-, 5-, 25-, and 100-year storm events, to determine how the stormwater collection system would react under these different storm conditions.

The 25-year storm event was modeled to identify the required capital improvements should the City choose to use a 25-year design storm in the future, rather than the 10-year storm that is the design basis of the existing system. The costs associated with upsizing the stormwater conveyance system were determined to be excessive compared to maintaining the current 10-year design storm basis. The 100-year event was also modeled to assist in identifying properties that would be impacted by this large storm event.

The 2-year storm was used to evaluate the potential for stream erosion because this size storm is responsible for most sediment transport and channel-forming activity in streams. The channel-forming or dominant discharge is a theoretical discharge that, if maintained in an alluvial stream over a long period of time, would produce the same channel geometry that is produced by the long-term natural hydrograph. Channel-forming discharge is the most commonly used, single independent variable that is found to govern channel shape and form. Channel-forming discharges are found in storm events with 1- to 2.5-year recurrence intervals (USDA, 1998). Studies in King County, Washington, confirmed that the 1- to 2-year flows moved the most sediment over time (Booth, 1997).

The velocity at which channel erosion begins depends on a number of factors including the slope of the channel, steepness of the streambanks, soil characteristics, and the amount and type of stabilizing vegetation. A threshold of 4 feet per second was chosen for stream erosion based on allowable velocities for cohesive soils and/or grass-lined channels (NCSCC, 1988; MDOE, 1998; Smoot and Smith, 1999).

3.3 ENGINEERING STANDARDS

The following engineering standards were used to determine system deficiencies and needed improvements:

- Surcharged pipes were classified as undersized. However, they were not recommended for replacement unless surface flooding had also been observed.

- The installation of a parallel pipe to increase capacity was not considered to be cost-effective due to conflicts with other utilities. Replacement of the undersized pipe with a larger pipe was recommended as the more desirable solution.

- Culverts were considered to be appropriately sized if they could convey the 10-year design storm flows without creating upstream backwater conditions. Culvert replacement or the installation of a parallel culvert was recommended when headwater conditions created by an undersized culvert threatened upstream property or the stability of a roadbed. The recommendation of either a new replacement culvert or a parallel culvert was based on cost and on the physical geometry of the site.

- Existing bridges that passed flows from the 10-year design storm were considered adequately sized. Bridges for Oregon Department of Transportation (ODOT) roads are designed for larger storm events, but the SWMP identifies only the deficiencies associated with the 10-year design storm.

3.4 MODELING PARAMETERS AND ASSUMPTIONS

The product, XP-SWMM (Stormwater Management Model) version 5.2, was selected as the hydrologic and hydraulic model for the project. The model enables the user to perform a detailed examination of flooding, backwater, and velocities within the stream and piped system. XP-SWMM contains a modified version of the U.S. Environmental Protection Agency's SWMM program.

The model was used to predict peak flows, water elevations, and velocities for existing and future development conditions for 2-, 5-, 10-, 25-, and 100-year design storms. The model was used to identify flooding problems, size pipes and culverts, and identify stream reaches susceptible to excessive erosion.

The following subsections describe the design storms used in the modeling process. The subsections include a summary of model calibration efforts and a brief discussion of model assumptions.

3.4.1 Design Storms

The design storm used in the modeling was based on an actual Corvallis rainfall event. The rainfall distribution (incremental volume over time) of the design storm was based on the rainfall pattern from the December 24 to 29, 1998 storm event. During this 5-day period, 5.15 inches of rain fell with 3.64 inches accumulating in the 24-hour period beginning at 1 p.m. on December 27. This 24-hour rainfall volume is approximately equal to the 10-year event predicted by the National Oceanic and Atmospheric Administration (NOAA) Atlas X (1973) commonly used for deriving design storms. The days before and after this event were included in the model to allow the model time to come to equilibrium with the rainfall and soil moisture conditions.

To model other storm events, the rainfall distribution for the 10-year storm was modified by multiplying the incremental volumes by the factors listed in Table 3-1. The storms used in the model included the 2-, 5-, 10-, 25-, and 100-year storms.

Table 3-1. Design Storm Rainfall Multiplier

Return frequency (years)	2	5	10	25	100
Multiplier	0.7	0.8	1.0	1.1	1.3

This approach was used in lieu of a traditional synthetic design storm, such as the SCS Type IA distribution. The U.S. Soil Conservation Service developed this methodology in the mid-1980s (SCS, 1986). Although the SCS Type IA storm has been widely used throughout the Pacific Northwest, the use of a rainfall distribution based on historic rainfall records more closely reflects the type of storm distribution found in the Willamette Valley. In general, the typical Willamette Valley storm distribution does not have the short, steep sloped hyetograph (a graph showing rainfall over a period of time) associated with the SCS Type IA storm. To more closely approximate storm patterns found in Corvallis, the hyetograph for the design storm had more gradual leading and trailing edges. (See Appendix C for more details.)

Peak flows in stormwater systems are highly dependent on the soil conditions present before a storm (antecedent conditions). The peak flow rate generated from a given storm may have a recurrence interval different from that of the rainfall event due to varying soil moisture conditions. Design storms constructed from SCS distributions and 24-hour rainfall volumes tend to create higher peaks than those that are observed in long (25+ year) simulations using actual rainfall records, (Bedient and Huber, 1993). Thus, the true return period for a simulated storm event is uncertain.

Distributions and 24-hour rainfall volumes create higher peaks and lower total volumes than what has been observed in long (40+ year) simulations using actual rainfall records. The SCS distributions do not accurately account for antecedent rainfall by allowing too much of the rainfall to infiltrate at the beginning of the storm.

3.4.2 Model Calibration

The calibration data used for this study was based on water surface elevations measured during the December 24 to 29, 1998 storm and from anecdotal information. The public provided information on storm and flooding events during public meetings and by City engineering and maintenance personnel familiar with the storm collection system. In addition, previous master planning efforts had model results that were compared to the new XP-SWMM models.

Calibration data was available for Dixon and Squaw Creeks. Table 3-2 presents the results of the calibration effort based on surface water elevations from the December 24 to 29, 1998 storm. In general, the model predicted water surface elevations similar to actual observed conditions. The results were consistent with model tolerances based on available channel and calibration data.

Table 3-2. Calibration Results

Location	Measured elevation, feet	Modeled elevation, feet
Dixon Creek		
9th Street bridge	217.8	218.6
Grant Avenue bridge	224.2	225.4
Garfield Avenue bridge	228.3	228.3
Circle Boulevard bridge	240.0	240.2
Squaw Creek		
Knollbrook Place bridge	225.7	225.6
Country Club Place culverts	237.5	237.8

3.4.3 Model Assumptions and Limitations

This modeling effort was primarily aimed at determining system deficiencies related to flooding and flow restrictions resulting from improper channel or pipe size. Modeling of the pre- and post-development peak runoff flows was not meant to be used to quantify the effects of urbanization. Instead, modeling data were developed to determine flow relative to conveyance capacity for the purpose of sizing pipes, culverts, and other structures. To develop conservative recommendations for storm drainage infrastructure, a worst-case scenario was modeled. That scenario assumed that the peak rainfall occurred coincident with high soil saturation and that the storage and infiltration capacity was low for both the pre- and post-development conditions. Thus, most of the precipitation that fell was converted to surface runoff, and this assumption led to pre- and post-development peaks that were relatively close and high in magnitude.

Although this assumption provided a sound approach for determining system deficiencies, it would not be appropriate for a modeling effort aimed at quantifying the differences in pre- and post-development runoff. While the modeled effect of little change in pre- and post-development peaks may be true for rare storms with return periods greater than 5 to 50 years and with high rainfall volumes, it would not be realistic for smaller, more frequent storms under less saturated conditions where a greater proportion of the precipitation that falls would be stored and routed as subsurface flow. A greater difference in development-related runoff response would result compared to that shown in the model. The difference would be more pronounced in the hillslope areas with deeper, loamier soils and greater storage capacities compared to the areas with clayey soils on the valley floor.

The model showed only runoff as surface flow; no subsurface and interflow storage and runoff mechanisms were included. The shift in the dominance of subsurface storage and runoff components in pre-developed conditions to surface runoff dominance in post-development conditions for the greatest percentage of storm events was not represented.

In addition, the modeling was not intended to provide direct water quality information or flow analyses necessary for determining mass loading of water quality components. Additional assumptions regarding modeling are in Appendix C.

3.5 METHODS FOR ESTIMATING COSTS

Project costs vary depending on the specific conditions of the project site. The accuracy of the cost estimate, therefore, depends on the amount of site information available, as discussed below. This information is expanded upon in Appendix D.

Type of Estimate – The costs developed for the SWMP are order-of-magnitude estimates, and not budget estimates or definitive estimates, as defined below.

- **Order-of-Magnitude Estimate** – This type of estimate is approximate, and is made without detailed engineering data. Calculations involving cost-capacity curves, scale-up or scale-down factors, and ratios are used in developing such an estimate. Typically an order-of-magnitude estimate is considered accurate within a range of plus 50 percent or minus 30 percent. That is, the final cost may be as much as 50 percent more or 30 percent less than the estimated amount.

- **Budget Estimate** – This estimate is prepared based on field observations, or using process flow sheets, layouts, and equipment details. A budget estimate is normally accurate within plus 30 percent or minus15 percent.

- **Definitive Estimate** – As the name implies, this is an estimate prepared from well-defined engineering data, such as construction plans and specifications. At a minimum, the data must include fairly comprehensive plot plans and elevations, piping and instrument diagrams, one-line electrical diagrams, equipment data sheets and quotations, structural drawings, soil data and drawings, and a complete set of specifications. The most accurate estimate would be based on construction drawings and specifications. The accuracy of a definitive estimate would fall within plus 15 percent or minus 5 percent.

Cost Index – All costs were updated using the *ENR Construction Cost Index* of 6300, representing costs for June 2000. The costs for acquisition of land or easements were not included for any of the engineered or riparian enhancement alternatives.

Provisions for Engineering, Administration, and Contingencies – Other project costs have been assumed to be equal to 45 percent of the construction costs of the project. This includes 20 percent for engineering, 5 percent for administration, and 20 percent for contingency. The same percentage was assumed for both engineered and restoration projects because, although the restoration projects typically involve less engineering, they require a large permitting effort.

3.6 IMPLEMENTATION STRATEGY

A strategy for implementing improvements was developed for each watershed. The strategy was based on a combination of four categories of activities, including capital projects, maintenance activities, policies, and community involvement. Each category is described below.

- **Capital Projects** – Capital projects include structural solutions to stormwater runoff, such as pipes, bridges, culverts, stream restoration, streambank stabilization, detention ponds, and swales.

- **Maintenance Activities** – City maintenance activities can address a number of flow and water-quality-related problems. The City can provide personnel and equipment for manual and machine-assisted removal of debris and sediment from channels, pipes, and culverts; alter street sweeping and catch basin cleaning activities; and take other measures.

- **Policies** – Upon its adoption, the SWMP, including the policies in Chapter 5, will become an amendment to the City of Corvallis Comprehensive Plan. Selected policies from the SWMP will also be added to appropriate sections of the Comprehensive Plan.

- **Community Involvement** – Community members can be involved in a number of activities that improve stream and riparian habitat conditions, such as educating the community and participating in volunteer activities for restoring or enhancing the watershed. Activities can be implemented by community groups, neighborhood associations, schools, scout troops, and stream associations.

The strategy for each watershed basin was divided into two levels of implementation: Short-Term Program and Long-Term Program. Each level of implementation is described below.

- **Short-Term Program** – Identifies the immediate needs of the stormwater system within each watershed and implements improvements over an approximate 10-year period. Improvements are implemented when funding and resources are available, and generally result in the highest benefit with the least amount of cost.

- **Long-Term Program** – Represents projects to further protect and restore the health of the watershed that would be implemented over a longer time frame, generally upon complete implementation of the Short-Term Program. In some cases, long-term programs may be implemented concurrent with the Short-Term Program, especially when the implementation is staged over a long period of time.

3.7 RELATED REGULATIONS

Several federal and State regulations govern various aspects of local stormwater management activities. These include the National Pollution Discharge Elimination System (NPDES), Total Maximum Daily Load (TMDL), and the Endangered Species Act (ESA). Each regulation addresses a different aspect of stormwater management and must be incorporated into a comprehensive management plan.

3.7.1 National Pollution Discharge Elimination System

The authorizing legislation for municipal stormwater management is the 1987 federal Clean Water Act (CWA) amendments. They provide for municipal discharge permits to be issued on a system-wide basis. Through this legislation, the NPDES requirements were expanded to include the regulation of stormwater discharges. Cities that discharge treated wastewater to a waterway currently operate wastewater treatment facilities under an NPDES discharge permit. Companies that discharge stormwater from industrial sites also receive permits under these requirements. Operation of a municipal separate storm sewer system (MS4) requires an NPDES permit. Agricultural stormwater is not currently managed by NPDES.

National stormwater permitting was initiated by the NPDES Phase I requirements promulgated in 1990. Phase I requirements focused on cities with more than 100,000 people, industrial facilities, and construction sites that disturbed 5 acres or more land. The Phase II requirements published in December 1999 extended the permitting to include "small" cities and construction sites that disturb lands from 1 to 5 acres. Corvallis is included in the Phase II permitting.

Regulations issued to implement the MS4 permitting system prohibit non-stormwater discharges to storm drains and require controls to reduce the discharge of pollutants from storm drains to the maximum extent practicable. The discharge of pollutants to storm drains is a largely urban non-point source pollution problem that is to be addressed by structural and non-structural improvements and activities. Rather than setting numerical effluent limits, the regulations encourage the management of stormwater through Best Management Practices (BMPs). BMPs aim to reduce erosion, manage chemicals, remove pollutants through maintenance practices including street sweeping, and educate the public in behaviors that place water quality goals at risk.

Specifically, the NPDES Phase II requires implementation of six minimum control measures. The rules require the permittee (i.e., the City) "to identify and submit to the NPDES permitting authority a list of BMPs that will be implemented for each minimum control measure. They also must submit measurable goals for the development and implementation of each BMP" (Federal Register, 1999). "In other words, EPA would expect Phase II permittees to tailor their stormwater management plans and their BMPs to fit the particular characteristics and needs of the permittee...." In addition, the permittee must show a schedule for implementing the program and definition of entity responsibility.

The six minimum controls with examples of appropriate BMPs are as follows:

1. **Public Education and Outreach** - Distribute brochures, flyers, or bill inserts to educate homeowners and business operators about the problems associated with stormwater runoff and the steps they can take to reduce pollutants in stormwater discharges.

2. **Public Participation/Involvement** - Provide notice of stormwater management plan development and hold meetings at which citizens and business operators are encouraged to communicate ideas. Include citizen and business representatives in a Citizens' Advisory Group.

3. **Illicit Discharge Detection and Elimination** - Inventory and map the stormwater system and test for the possible cross-connections of sanitary wastewater to the stormwater conveyance system. Modify system to eliminate illicit discharges.

4. **Construction Site Runoff Control** - Require the implementation of erosion and sediment controls, and control other waste. Review site plans and perform periodic inspections. Establish penalties for non-compliance.

5. **Post-Construction Runoff Control** - Require the consideration and implementation of post-construction stormwater controls for any new construction. This might include on-site detention, pollutant reduction, or both.

6. **Pollution Prevention/Good Housekeeping** - Train maintenance staff to employ pollution prevention techniques and to maintain and operate public facilities to ensure the most efficient pollutant reduction. Materials handling, fleet vehicle maintenance, and application of chemicals in public areas, such as parks and roadways, should be managed to reduce impact on stormwater quality.

The Oregon Department of Environmental Quality (DEQ) is the NPDES permitting authority in the state of Oregon. The DEQ will be writing the Phase II NPDES permits with review and required approval from the EPA. The City will be required to submit a permit application or Notice of Intent by March 2003. The City must fully develop and implement a program within 5 years of issuance of the permit. Within the planning period, it is anticipated that Corvallis will be large enough to qualify as an urban area and will be subject to Phase II evaluation. The DEQ has not yet completed the task of implementing all Phase II regulations.

3.7.2 Total Maximum Daily Load

The CWA requires that each state implement activities to protect the quality of its rivers, streams, and other water bodies. The DEQ has primacy for implementing this law, including the responsibility for developing standards to protect the beneficial uses that have been determined for each water body. The DEQ developed the 303(d) list to identify water bodies that do not meet current standards. Once a water body has been listed, local governments are responsible for working with the

DEQ to develop and implement recovery plans to protect the beneficial uses. See Table 3-3 for the Willamette River and Marys River sections listed by the DEQ.

The DEQ will develop Total Maximum Daily Load (TMDL) levels for each stream on the 303(d) list within 10 years of its listing. TMDLs define the quantity of pollutant that can enter a water body without violating water quality standards. TMDLs apply to both point (end of pipe) and non-point (stormwater runoff) sources, and include a factor of safety to account for uncertainty and allow for some future discharges into the water body. TMDLs have not yet been established for Marys River or the Upper Willamette Basin. The DEQ is scheduled to complete these by 2003. To date, a lack of resources has restricted the DEQ's ability to complete the necessary studies within the specified timeframe.

Table 3-3. DEQ 303(d) Listings

DEQ record ID	Boundary	Parameter/criteria	Basis for consideration
Willamette River (Upper Willamette Basin)			
5867	Calapooia River to Long Tom River	Temperature/rearing 64° F	Summer values exceed temperature standard 64° F.
6043	Calapooia River to Long Tom River	Bacteria/water contact recreation	12 percent of the samples exceeded fecal coliform standard (400 count/100ml)
7090	Calapooia River to Long Tom River	Toxics/tissue-mercury	Health Division consumption health advisory issued for mercury in fish tissue (0.63 ppm); reference level (0.35 ppm)
Marys River			
5920	Mouth to Greasy Creek	Temperature/rearing 64° F	Summer values exceed temperature standard 64° F.
6055	Mouth to Greasy Creek	Bacteria/water contact recreation	Values exceed fecal coliform standard (400 count/100 ml) with a maximum value of 2,400 count/100 ml
6300	Mouth to Greasy Creek	Flow modification	Low flows have been suggested as cause of cutthroat population decline

Once TMDLs have been established for a water body, the DEQ will require the preparation of a comprehensive watershed plan that will define how the water body will be brought into compliance with water quality standards. The plan must address all activities within the watershed that could impact water quality, including industrial and municipal treatment facility discharges, agricultural and irrigation flows, stormwater runoff, construction site erosion, streambank shading, and land development methods. In addition, the plan must be prepared in accordance with federal and State laws.

3.7.3 Endangered Species Act

The Endangered Species Act (ESA) was enacted to prevent extinction of certain species of fish, wildlife, and plants that have seen significant declines in their populations within a defined geographic range or Evolutionarily Significant Unit (ESU). The rules prohibit a "take," which the ESA defines as "harass, harm, pursue, hunt, shoot, wound, trap, capture, or collect, or attempt to engage in any such conduct." The rules go into effect immediately upon listing by the government. The term "harass" is further defined as any intentional or negligent act that creates the likelihood of injuring wildlife by disrupting normal behavior such as breeding, feeding, or sheltering, whereas "harm" is an act that either kills or injures a listed species. By definition, "take" and "harm" can include any habitat modification or degradation that significantly impairs the essential behavioral patterns of fish or wildlife.

The National Marine Fisheries Service (NMFS), a section within the National Oceanic and Atmospheric Administration (NOAA), is responsible for administering the ESA rules as they apply to marine fish species. The U.S. Fish and Wildlife Service (USFWS) protects freshwater fish and all other animal and plant species.

ESA requirements apply to any activity that could result in a take of an endangered species. According to the NMFS, "Any government body authorizing an activity that specifically causes take may be found to be in violation of the Section 9 take prohibitions." Corvallis manages a number of activities that could potentially impact endangered species, including:

- Planning and zoning
- Development permitting
- Erosion and sediment control
- Floodplain management
- Water use
- Stormwater discharge
- Wastewater discharge
- Road and bridge construction and maintenance
- Pesticide, herbicide, fertilizer, and other chemical use
- Riparian area protection, alteration, or development
- Wetland protection, alteration, or development

In addition, NMFS and the USFWS have a policy to identify specific activities considered likely to result in take. As indicated in the *Federal Register* "Notice of Threatened Status for Two ESUs of Steelhead in Washington and Oregon" (U.S. Department of Commerce, March 1999), such activities include, but are not limited to:

1. Destroying or altering the habitat of listed salmonids (through activities such as removal of large woody debris or riparian shade canopy, dredging, discharge of fill material, draining, ditching, diverting, blocking, or altering stream channels or surface or ground water flow).

2. Discharging or dumping toxic chemicals or other pollutants into waters or riparian areas supporting listed salmonids.

3. Violating federal or State CWA discharge permits.

4. Applying pesticides and herbicides in a manner that adversely affects the biological requirements of the species.

5. Introducing non-native species likely to prey on listed salmonid species or to displace them from their habitat.

3.7.3.1 Enforcement

Enforcement of ESA rules will be by the NMFS under Section 9 of ESA. Also, third parties may bring suit under Section 9 against the entity or person alleged to have committed a take. A take permit or a 4(d) take limit is not required if a take does not occur. However, an entity or person will be at risk of violating the rules unless a certainty of compliance is provided as offered under Section 4(d), Section 10, or the federal nexus.

3.7.3.2 Listed Wildlife and Plants

Listings define the status of the species as endangered, threatened, or not warranted. Endangered is defined as, "in danger of extinction throughout all or a significant portion of its range," while threatened means, "likely to become endangered within the foreseeable future throughout all or a significant portion of its range." Two species of fish have been listed for the Corvallis area:

- Oregon Chub, Oregon ESU — Endangered
- Chinook salmon, Upper Willamette River ESU — Threatened

The USFWS has listed 28 species of plants and animals as endangered or threatened in Oregon. The City may request a report from the Oregon Natural Heritage Program that lists species identified in the Corvallis area. Regardless, the determination of whether any of the listed species are in a particular area is the responsibility of the owner/developer of the land. In addition, listings can change; therefore, it is imperative that the owner/developer of a property determine the applicable listings at the time of the proposed activity.

3.7.3.3 Complying with the Endangered Species Act

The final rules defining the NMFS requirements for conserving the listed steelhead and salmonid ESUs were published in the *Federal Register* on July 10, 2000. The discussion presented in this document is based on the final rules and on information gathered through discussions with the NMFS and others involved in the 4(d) exemption process. The final 4(d) rules for the different ESUs have different effective dates. The effective date for the salmon ESUs is January 8, 2001.

A number of jurisdictions, including Corvallis, are negotiating with NMFS to define the programs that would be required to provide eligibility for the 4(d) exemption. NMFS will apply the following 12 evaluation considerations when reviewing Municipal, Residential, Commercial, and Industrial (MRCI) development ordinances or plans to assess whether they adequately conserve listed salmonids by maintaining and restoring properly functioning habitat conditions:

1. Ensures that development will avoid inappropriate areas such as unstable slopes, wetlands, areas of high habitat value, and similarly constrained sites.

2. Adequately avoids stormwater discharge impacts to water quality and quantity or to the hydrograph of the watershed, including peak and base flows of perennial streams.

3. Adequately protects riparian area management requirements to attain or maintain properly functioning conditions (PFC) around all rivers, estuaries, streams, lakes, deepwater habitats,

and intermittent streams. Compensatory mitigation is provided, where necessary, to offset unavoidable damage to PFC due to MRCI development impacts to riparian management areas.

4. Avoids stream crossings by roads, utilities, and other linear development wherever possible. In addition, where crossings must be provided, minimizes impacts through choice of mode, sizing, and placement.

5. Adequately protects historical stream meander patterns and channel migration zones, and avoids hardening of stream banks and shorelines.

6. Adequately protects wetlands and wetland functions, including isolated wetlands.

7. Adequately preserves the hydrologic capacity of permanent and intermittent streams to pass peak flows.

8. Includes adequate provisions for landscaping with native vegetation to reduce the need for watering and application of herbicides, pesticides, and fertilizers.

9. Includes adequate provisions to prevent erosion and sediment runoff during construction.

10. Ensures that water supply demands can be met without impacting flows needed for threatened salmonids, either directly or through groundwater withdrawals, and that any new water diversions are positioned and screened in a way that prevents injury or death of salmonids.

11. Provides necessary enforcement, funding, reporting, implementation mechanisms, and formal plan evaluations at a minimum of every 5 years.

12. Complies with all other State and federal environmental and natural resource laws and permits.

The NMFS recommends a "plug and play" approach to meeting the 4(d) requirements. Jurisdictions would produce plans to be reviewed by the NMFS. If approved, the plans would be published in the Federal Register and made available for others to adopt. While adoption in this manner would save new applicants considerable time and effort in developing a compliance plan, the plan must still be tailored to meet the specific needs of the listed species within the applicant's jurisdiction. The NMFS must review and approve the modified plan before it can provide protection against take.

Although there is currently no prototype format for a stormwater management plan to serve as a 4(d) limitation on the take prohibitions, the NMFS is requesting that cities meet with them to discuss ways in which their programs can serve as an application for a 4(d) limitation on the take prohibitions. Other than applicable Section 7 consultation requirements, the NMFS does not have authority to require review of a city's stormwater management plan. However, receiving a limit on the take prohibitions under section 4(d) would provide legal assurance to the City that it would not be subject to an NMFS enforcement action or a third-party lawsuit.

3.7.3.4 Corvallis Endangered Species Act Planning

The City is undertaking a separate work effort to address the community's response to the Endangered Species Act. The work consists of collecting data, conducting inventories, and applying scientific methods to evaluate fish habitat impacts. Options and strategies will be developed to prevent further habitat degradation. Results of this effort may coincide with many of the recommendations contained within this document.

3.7.4 Floodplain Management

Congress initiated the National Flood Insurance Program (NFIP) in 1968 to control costs to all levels of government due to flood disaster relief. The Federal Insurance Administration, part of the Federal Emergency Management Agency (FEMA), administers the NFIP. The NFIP insurance coverage is available only in communities that implement regulations to reduce the likelihood of future flood damage. Zoning laws, building codes, and development regulations serve to manage the floodplain by setting restrictions and requirements for new construction within flood-prone areas.

Congress modified NFIP in 1973. Funds related to federal programs that involve structures within the 100-year floodplain can be granted only if the structure is covered under a flood insurance policy and the community participates in the NFIP.

The National Flood Mitigation Fund was set up by the FEMA as the result of 1994 legislative reforms. The FEMA can fund planning and actual projects on a cost-sharing basis of 25 percent state and local funding and 75 percent federal funding, contingent on the development of a flood mitigation plan.

Current FEMA regulations define two flood zones:

> **Floodway** – Part of the 100-year floodplain that must be kept clear of fill or other obstructions to convey the 100-year flood without an excessive increase in flood elevations
>
> **Floodway fringe** – Portion of the 100-year floodplain outside of the floodway. This may be developed if the fill does not cause the 100-year flood elevation in the floodway to rise more than 1 foot.

Corvallis has its own definition for floodway and floodway fringe. See section 5.4.5, Floodplain Management, in Chapter 5.

To enter the regular NFIP program, a community must complete a detailed technical study of flood hazards. A floodplain study determines the elevations of floods of varying intensity and the floodway boundaries. This information is presented on a Flood Insurance Rate Map and Flood Boundary and Floodway Map. The community adopts and enforces regulatory standards based on these maps.

Physical data developed as part of the SWMP's hydrologic/hydraulic modeling could be used to update or develop FEMA maps. However, most master planning efforts do not provide the level of technical analysis required to satisfy the FEMA requirements. As part of a FEMA update, maps could be developed that account for planned improvements to the stormwater drainage system. This could be advantageous to the community if the actual 100-year floodplain is less extensive than currently shown on FEMA maps, resulting in a reduction in the area that is impacted by FEMA requirements.

3.7.5 Wetland Management

Section 10 of the Rivers and Harbors Act of 1899 requires approval prior to work in or over "navigable waters" of the United States, or to work that affects the course, location, condition, or capacity of such waters. The U.S. Army Corps of Engineers (COE) is responsible for administering the Act. By definition, the wetlands and streams in and around Corvallis are covered by this requirement. Typical activities requiring Section 10 permits are:

- Construction of piers, wharves, bulkheads, marinas, ramps, floats, intake structures, and cable or pipeline crossings.
- Dredging and excavation.

Section 404 of the CWA requires approval prior to discharging dredged or fill material into the "waters of the United States." The COE is also responsible for administering Section 404 of the CWA. Again, "waters of the United States" includes essentially all surface waters such as all navigable waters and their tributaries, all interstate waters and their tributaries, all "wetlands adjacent" to these waters, and all impoundments of these waters. Typical activities requiring Section 404 permits are:

- Depositing of fill or dredged material in waters of the U.S. or adjacent wetlands.
- Site development fill for residential, commercial, or recreational developments.

As defined in Section 404, wetlands are:

> Those areas that are inundated or saturated with surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.

In addition to the COE, the Oregon Division of State Lands (DSL) regulates activities in wetlands. The primary state regulation that affects development activities in and near wetlands is the Removal-Fill Permit Program, ORS 196.800 through 196.990, administered by the DSL. The DSL uses the 1987 COE manual to delineate wetlands.

The Removal-Fill Permit Program regulates:

- The removal of 50 cubic yards or more of material from one location in any calendar year.
- The filling of a waterway with 50 cubic yards or more of material at one location at any time.

The DSL also regulates irrigation ditches and intermittent streams if they are considered a source of food for wildlife or provide habitat for game fish. Further, the DSL regulates intermittent streams if they meet federal wetlands criteria.

Any public or private project that involves filling or removing fill from wetlands included in the Corvallis wetland inventory requires a DSL permit if the quantities exceed 50 cubic yards. The City's Wetland Factors Map identifies hydric soils (often a wetland indicator) and National Wetland Inventory wetlands. In addition, the City has conducted basin-wide wetland inventories for Squaw Creek, Jackson Creek, and Frazier Creek. The basin-wide inventories identify the probable wetland locations. The absence of wetlands, streams, and drainage channels on inventory maps does not automatically relieve the owner or developer of acquiring permits. Wetlands can be present on a site and not appear on an inventory map. The owner or developer must determine if wetlands are present and determine whether a DSL permit is required.

CHAPTER 4

STUDY AREA CHARACTERISTICS

This Stormwater Master Plan (SWMP) is based on the physical and social characteristics of the study area. These characteristics include land use, topography, geology, soils, climate, and the natural streams and manmade pipe and channel systems that comprise the overall conveyance system. Each characteristic to some degree influences the quantity and quality of stormwater runoff and the health of the watershed. This chapter presents the characteristics used as the basis for developing the SWMP. In addition, this chapter describes the general impacts of urbanization on a watershed.

4.1 GENERAL DESCRIPTION OF THE STUDY AREA

This section describes the physical and social characteristics that influence the quantity and quality of stormwater runoff within the study area shown in Figure 4-1. The description focuses on the area within the City, although the overall planning effort includes the watersheds in their entirety. A general description of the area outside of the city limits is presented in Section 4.3.

4.1.1 Land Use

The City of Corvallis (City) is the county seat of Benton County, Oregon. It lies near the middle of the Willamette Valley, home to over two-thirds of Oregon's population and the majority of its industries. Corvallis is well connected by transportation lines to the rest of the Willamette Valley. Oregon State Highways 34 and 20 provide east-west access and Highway 99 runs north to south. United States Interstate 5 is located about 11 miles to the east. A railroad line operated by the Willamette and Pacific Railroad also serves Corvallis, as does the municipal airport located south of the City.

Benton County was settled in the mid-1800s with statistics listing a population of 3,065 in 1860. The population has increased about 30 percent every 10 years since 1900, although the two decades following World War II saw a growth rate nearly double the long-term average. Benton County's present-day population totals over 76,000, nearly 51,000 of which live in Corvallis.

Table 4-1 lists the population increases of several nearby cities and towns. Albany and Philomath had large increases in population during the 1990s, while Benton County, including Adair Village and Corvallis, lagged behind the state average. The increase in population has caused changes in the way land is used in the area and more changes are likely in the future.

Table 4-1. Recent Area Populations

	1980	1990	1997	1998	Percent increase (1990 to 1998)
Oregon	2,633,105	2,842,321	3,217,000	3,267,550	15
Benton County (including Corvallis)	68,211	70,811	76,700	76,600	8
Corvallis	40,843	44,757	51,145	49,630	11
Adair Village	NA	554	570	570	3
Albany	NA	29,540	37,830	38,925	32
Philomath	NA	2,983	3,380	3,770	26

Source: Portland State University – Population Research Center
Note: NA – not available

The most prevalent existing land use, based on 1998 City tax lot information, is low-density residential, followed by Oregon State property as listed in Table 4-2. Unzoned land use includes areas not classified by existing land use categories, such as city streets. The projected future land uses shown in Figure 4-2 represent large declines in vacant and agricultural categories. The future scenario includes large increases for commercial, industrial, residential, and open space-conservation categories.

Table 4-2. Land Use within the Urban Growth Boundary in Acres

Hydrologic land use category	Currently developed [1]	Future planned [2]
Residential – low	4,199	6,477
Institutional (schools, OSU)	2,639	2,446
Open Space – agricultural	2,137	850
Industrial	1,030	2,000
Residential – med/high & medium	863	1,261
Residential – high	559	879
Commercial	180	560
Research/technology	0	111
Open Space – conservation	0	1,863
Vacant	4,431	0
Unzoned	1,969	1,561
Total area	18,008	18,008

[1] From existing tax lot information.
[2] From Corvallis Comprehensive Plan, 1998

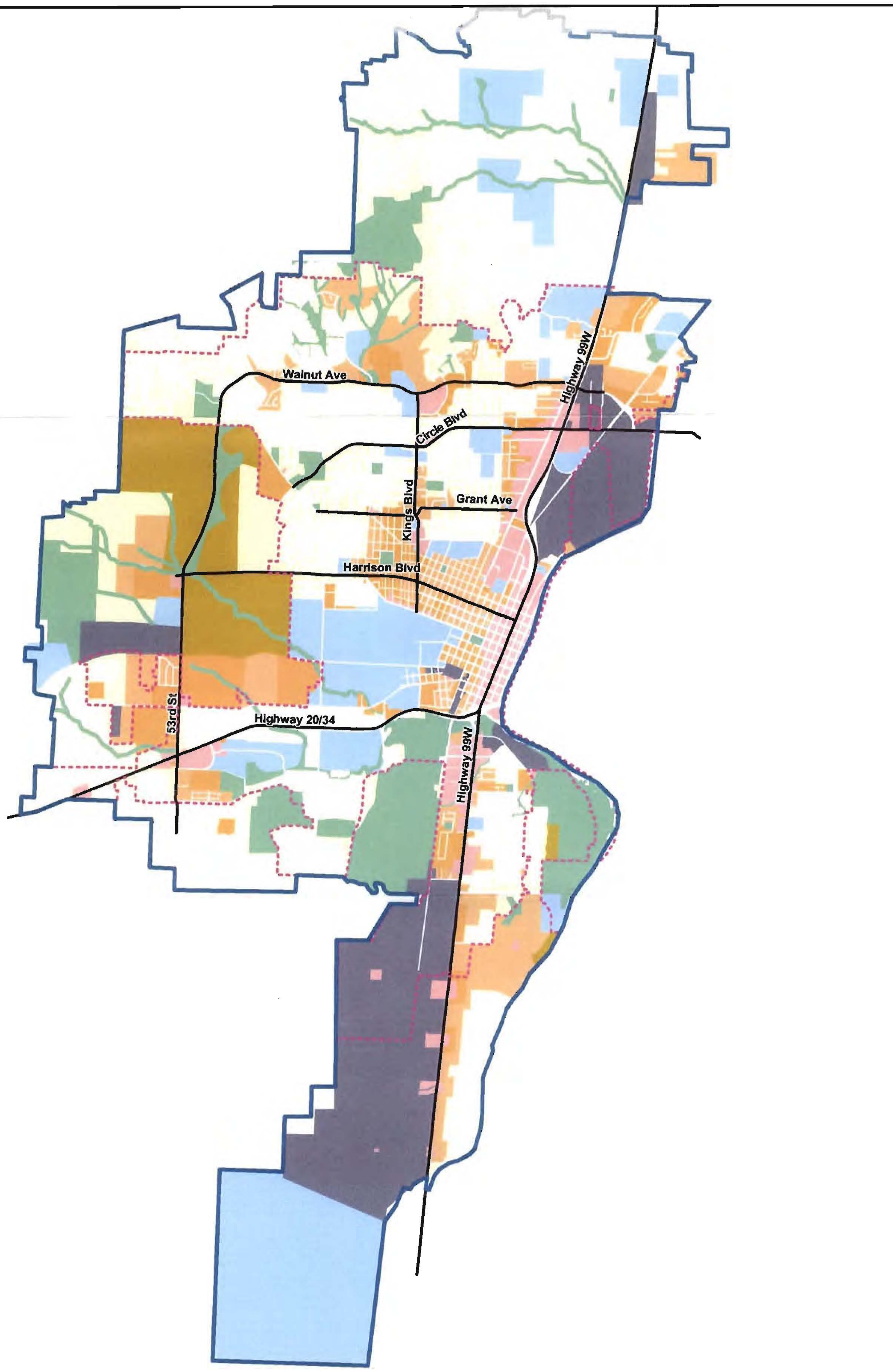


Figure 4-2 Projected Future Land Use

LEGEND

Urban Growth Boundary

City Limits

Projected Future Land Use
(from City of Corvallis Planning Dept)

- Commercial
- Industrial
- Agricultural
- Forest
- University/Institutional
- High Residential
- Low Residential
- Medium Residential

N

report/figures/final/Fig4-2.wor, November 3, 2000, base data from City of Corvallis GIS Department

New houses, roads, parking lots, and commercial buildings have added to the impervious surface areas within the study boundary. Impervious surfaces do not allow water to infiltrate into the ground as it usually does in undeveloped areas. This causes an increase in the volume and speed of runoff. Table 4-3 shows the imperviousness percentages by land use category.

Table 4-3. Impervious Percentage by Land Use

Land Use Category	Imperviousness (%)
Commercial – high	90
Commercial – medium	87
Research/technology	76
Institutional (schools, OSU)	70
Residential – high	63
Industrial	60
Residential – medium	50
Residential – low	40
Open Space – agricultural	15
Vacant	10
Open Space – conservation	5

The imperviousness percentages were calculated based on the City's photogrammetric maps that show buildings, streets, and sidewalks. Commercial areas have the highest imperviousness percent, followed by research/technology, and institutional areas. For the purposes of this study, the un-zoned areas listed in Table 4-2 were distributed proportionally into the other land uses shown in Table 4-3. Commercial land use includes both the downtown core area and shopping centers/commercial strips, such as those along 9th Street and Kings Boulevard. The imperviousness percentage of industrial areas in Corvallis is less than what is typically assumed for cities this size, because of the campus nature of several industrial developments. The Hewlett-Packard facility is an example of this type of development. Current land use policy encourages the preservation of significant natural resources, further reducing the impervious cover in the developed areas. The City also encourages increased density and compact development, which is likely to have the opposite effect and increase the impervious cover. It is anticipated that the net result of impervious cover will be similar to what it is today.

Land use not only influences the quantity of stormwater runoff, but also the quality of the runoff. Areas of high imperviousness, such as industrial areas and streets, can have some of the highest pollutant loads, and open spaces the lowest. Information on the pollutant loads associated with various land uses is listed in Table 4-5.

4.1.2 Topography

Topography affects many of the characteristics of stormwater runoff. Hilltops, ridgelines, and other high points determine drainage basin boundaries. Ground slope influences the amount and velocity of runoff. Steeper slopes drain easily, but are prone to erosion. Flat areas experience greater flooding and often have sediment deposits. Topography can also limit the type of stormwater facilities that can be sited within a given area and their effectiveness.

Corvallis is located at the junction of the Willamette and Marys Rivers. Marys River splits the City into northern and southern sections. The southern section includes the floodplain of the Willamette River. The northern section contains three topographic regions: the floodplain of the Willamette River, the Willamette Valley floor, and the foothills of the Coast Range. The Willamette River also forms the eastern boundary of the City. The Willamette River floodplain lies in the northeast and southern part of the study area, with elevations that are subject to frequent flooding.

The Willamette Valley floor makes up most of the study area. Elevations range from 220 feet at the Willamette River to 480 feet at Witham Hill. The slopes of most conveyance facilities within this region are relatively flat and follow the terrain.

The foothills of the Coast Range lie west of 53rd Street and north of Walnut Boulevard. Most of the City's northern streams originate in the foothills outside the city limits. Ground slopes are moderately steep and elevations range up to 2,000 feet to the northwest.

The study area drains to the Willamette and Marys Rivers through a number of distinct watersheds. The watersheds are defined by the topography and by manmade structures, such as streets, that influence the direction of stormwater runoff. Six watersheds lie in the northern part of the study area:

- Dixon Creek
- Squaw Creek
- Jackson/Frazier/Village Green Creeks
- Sequoia Creek
- Garfield Basin
- Oak Creek

The southern part of the study area contains two watersheds:

- Marys River
- South Corvallis

4.1.3 Geology

Although this SWMP primarily addresses the impacts to the conveyance systems due to 150 years of human development, the effects of millions of years of geological processes continue to play an important role. The rock formations and soils of the area influence stormwater runoff rates, the rate of infiltration, and the elevation of the water table.

Parent materials in the Corvallis area originate from two primary sources: sedimentary deposits, and volcanic action. Some 40 to 60 million years ago, all of western Oregon was covered by a shallow sea in which thousands of feet of sediment accumulated. Volcanoes and uplifting of the land nearly 15 million years ago formed the Cascade and Coast Range Mountains. The Willamette Valley was formed and began to function as the main drainageway for transporting runoff and sediments eroded from the mountains (alluvium). Most of the soils in the study area are formed from terraces resulting from the sand and gravel alluvium deposited in the Willamette River Valley. The soils are relatively deep along the valley floor, but can be quite shallow in the steeper areas with only 1 to 4 feet of soil over bedrock. The depth to impermeable layers of rock and soil helps determine groundwater depths and influences infiltration rates.

Early development in Corvallis was generally restricted to the flatter, terraced areas, not far from the Willamette River. As the City grew, development expanded to the surrounding hills. In the future, additional development will occur on the steep hillsides to the north and west. These areas represent a potential for high velocity runoff that can erode the ground surface, particularly from construction sites, and erode and down-cut natural channels. In addition, development on steep slopes must maintain slope stability. Modifications to the natural drainage system can affect the potential for slope failures.

4.1.4 Soils

In addition to topography and impervious surfaces, soil type is another determinant of runoff volumes. The parent material, sediment grain size, saturation, and organic content are just a few of the factors that influence runoff rates and volumes. The Soil Conservation Service, now known as the Natural Resources Conservation Service (NRCS), investigated all soil factors, classified the soils and their areal extent, and categorized them as to suitability for farming, building, and recreation. More important to this study, however, is the soil classification into hydrologic groups based on the soil's engineering properties. Hydrologic groups can be used to estimate the total volume and peak runoff expected from storms.

Soils are grouped into four hydrologic categories: A, B, C, and D. Group A soils are coarsely textured and allow rapid infiltration of precipitation. Groups B, C, and D are increasingly finer-textured soils with correspondingly slower infiltration rates. Group D soils have the slowest infiltration rates and are associated with a high groundwater table, little depth to bedrock, and other factors that increase runoff.

The NRCS has classified Corvallis soils into four main soil associations as shown in Figure 4-3. Along the rivers and stream banks, the group D, poorly drained clay soils of the Waldo-Bashaw association predominate. Most of the valley floor contains silt loams of either the poorly-drained Dayton-Amity association (groups D and C, respectively) or the moderately well-drained Woodburn-Willamette association (groups C and D, respectively). Finally, in the headwaters of the northern streams, the Dixonville-Philomath association (groups C and D, respectively) of well-drained silty clay loams are found. The generally low infiltration rates and rapid runoff of Corvallis soils limits the use of stormwater management strategies that depend on infiltration.

4.1.5 Climate

The Corvallis area, like the rest of the Willamette Valley, has a maritime climate, which results in mild temperatures and ample rain, most of which falls in the winter months. Table 4-4 lists the most recent 30-year average for Hyslop Field, an experimental field station that Oregon State University maintains northeast of Corvallis.

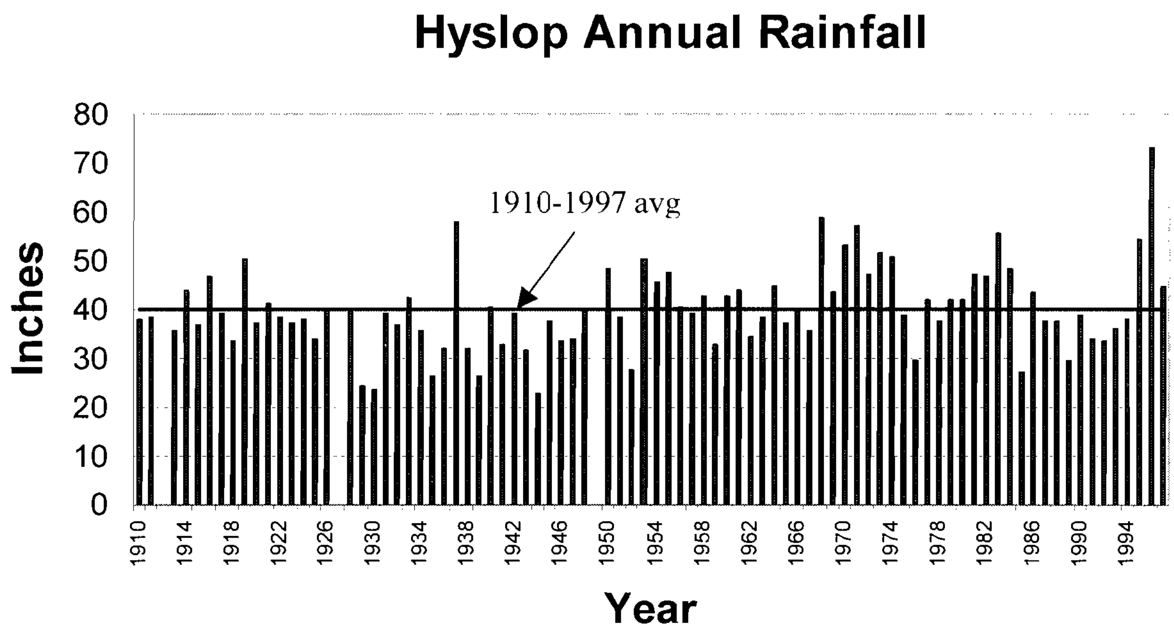
Table 4-4. Climate Statistics for Hyslop Field (1961-1990)

	Temperature (deg F)			Precipitation (inches)	
	Mean	Max	Min	Mean	Maximum (24hr)
Jan	39.3	45.5	33.0	6.82	4.28
Feb	42.7	50.4	35.1	5.04	2.76
Mar	46.0	54.9	37.0	4.55	1.90
Apr	49.3	59.5	39.2	2.56	1.83
May	54.6	66.1	43.1	1.95	1.58
Jun	60.9	73.1	48.6	1.23	1.33
Jul	65.6	80.2	51.0	0.52	1.26
Aug	66.2	81.1	51.3	0.87	1.48
Sep	61.6	75.4	47.8	1.51	2.18
Oct	53.0	64.3	41.7	3.11	1.81
Nov	45.1	52.3	38.0	6.82	2.68
Dec	39.7	45.6	33.9	7.72	2.87
Annual	52.0	62.4	41.6	42.70	

Source: Oregon State University

Due to the cyclic nature of climate, a 30-year record is not a sufficient length of time for planning and design purposes. Figure 4-4 shows annual rainfall in an 87-year span and depicts cyclical patterns in the Corvallis area. The drought of the 1930s is plainly apparent in the graph, as are the wet years from 1968 to 1974. More recently, the years from 1987 to 1994 all show below-average rainfall, while 1995 to 1998 show above-average rainfall.

Figure 4-4. Annual Rainfall at Hyslop Experimental Field

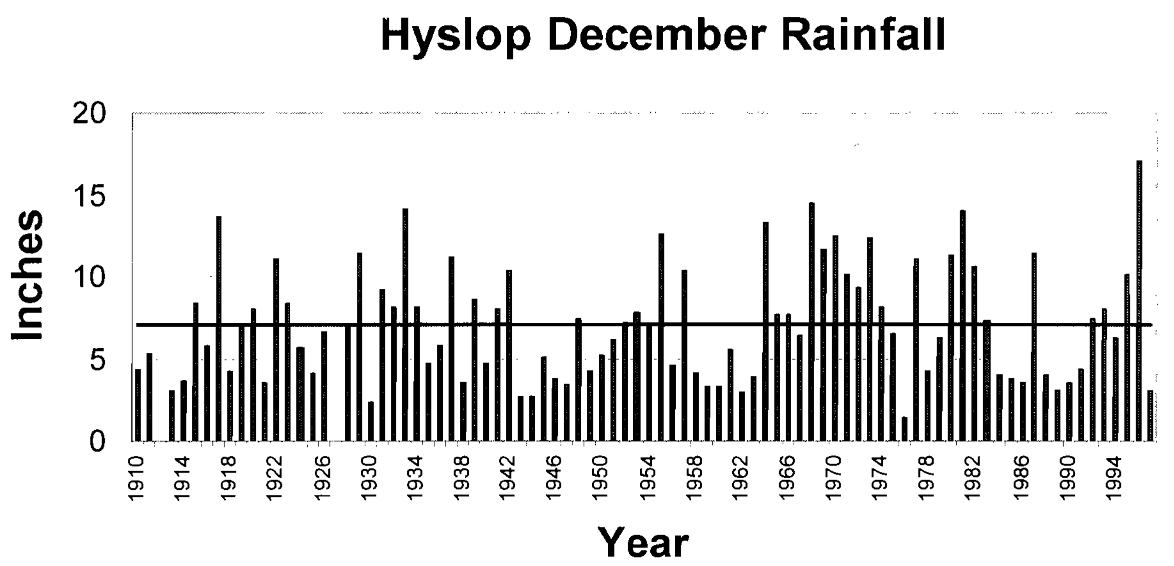


These long-term trends generally coincide with river and stream flows. However, short-term variations in the weather also play a significant role. For instance, in 1964 (the year of a severe flood event), the annual rainfall was 44.7 inches, only slightly above the long-term average of 40.1 inches. Figure 4-5 shows rainfall for the month of December over the same span of years as in Figure 4-4. A comparison of the monthly record shows that the December 1964 rainfall (13.27 inches) was nearly twice the long-term average for December (7.07 inches). Marys River had a 50-year flood event on December 22, 1964. These large deviations from average annual and monthly values must be considered during the stormwater planning process.

In addition to variations over time, annual rainfall varies spatially. The 30-year average is 42 inches on the valley floor and about 50 inches in the Oak Creek headwaters. Measurable precipitation (0.01 inches or more) occurs more than 150 days a year on average on the valley floor. Over 70 percent of the precipitation occurs from November through March. The vast majority falls as rain—only about 8 inches of snow is seen annually.

The hottest month in Corvallis is July with average temperatures of 69.8 degrees F. February is the coldest month with a 42.1 degrees F average. February has the lowest average soil temperatures, 38.6 degrees F, although extremes may reach below freezing for brief periods.

Figure 4-5. December Rainfall at Hyslop Experimental Field



4.1.6 Habitat and Vegetation

Prior to European settlement, many of the rivers and creeks of the Willamette Valley had broad, braided channels. Forests of alder, big leaf maple, black cottonwood, Oregon ash, and willow formed riparian corridors 1 mile or wider in many places. The land outside the corridors was kept open through seasonal burning by the native Kalapuya people. Due to high winter rainfall and impermeable clay soils, seasonally wet prairie occupied much of the open areas. Common camas, a wet prairie forb, was a major food source of the Kalapuya. Tufted hairgrass was also common in the wet prairies, along with many other grasses, sedges, forbs, and shrubs. On higher ground and along seasonal drainages, fire-tolerant trees such as Oregon white oak and Douglas fir grew in forests and open savannas, along with grand fir, ponderosa pine, and Pacific Madrone.

The natural habitat within the study area is influenced by the maritime climate, the topography, and the soil type (predominantly clay). The resulting natural habitat is oak and Douglas fir forests in the upland areas, and cottonwood, ash, and willow thickets along the numerous riparian corridors. The natural habitat has been heavily impacted by human activities, beginning with farming in the mid-1800s. This impact has dramatically increased with post-World War II urbanization. Some of the most obvious changes have been in the hydrologic cycles and vegetation of the study area. Today, the narrow, discontinuous strips of vegetation remaining along most of the City's streams provide limited habitat value.

Urban land use has greatly altered riparian vegetation in Corvallis. Stream confinement and channelization have resulted in higher than normal rates of downcutting in many areas, hydraulically disconnecting the streams from their floodplains and leaving riparian vegetation high and dry. Excessive erosion and sediment deposition resulting from downcutting and other human disturbances also harm riparian vegetation. Other stresses include pollution and habitat fragmentation. These stresses have made the native plant communities especially vulnerable to colonization by invasive and/or exotic species. Himalayan blackberry and reed canarygrass have taken over many riparian areas in Corvallis, growing as virtual monocultures and displacing more diverse, native plant communities.

The development of vacant land not only increases the amount of impervious area, but also decreases the storage provided by vegetation that intercepts precipitation before it reaches the ground. Stands of conifers intercept the most precipitation, at an estimated 28 percent. The interception rate for deciduous trees is 13 percent, which is similar to grasses at 10 to 20 percent (USDA, 1998). Vegetation also increases the available water-holding capacity (AWHC) of the soil via macropores within plant roots. The AWHC of soils covered with an impervious surface is assumed to be negligible or 1 millimeter (mm); grass and shrubs provide 103 mm in silty clays; mature forests provide 175 mm (Ferguson, 1994). Both the interception and AWHC factors are much more significant during dry, summer, weather conditions than during winter when saturated soils are more common.

Urban development has large impacts on natural resources and habitat. Throughout the watershed, the reduction in trees and shrubs in favor of lawns decreases available food and nesting sites. When food and nesting sites are still available, the fragmentation of habitat may prevent travel between them and water sources. Application of pesticides, collisions between animals and vehicles, and predation by domestic pets also increase with urbanization in the watershed. Within the stream corridor itself, increased flows from more impervious areas may cause erosion of stream banks or resuspension of deposited sediments. Rapid runoff means less infiltration to replenish groundwater, leading to lower natural-base stream flows during summer. This is offset by summer irrigation and runoff in developed areas that contribute to base stream flows. Removal of trees can lead to increased stream temperatures, which decreases dissolved oxygen in the water. All of these potential effects of development reduce habitat value.

The recent Endangered Species Act listing of Chinook salmon and steelhead for the Upper Willamette River has brought habitat concerns to the forefront of watershed planning in the area. The listing will likely affect development and other construction- and maintenance-related activities in the Corvallis area. Work within the streams may be subjected to more scrutiny. Proposed alternatives for addressing stormwater-related deficiencies need to be "fish-friendly," such as culverts that allow fish passage.

4.1.7 Fisheries and Wildlife

Corvallis streams support a diversity of fish species. Many species are native and, although they serve important roles in stream ecology, they often go unnoticed. Native fish include northern pikeminnow, largescale sucker, peamouth, sculpin, dace, chiselmouth, and whitefish. Other species such as largemouth bass, smallmouth bass, and bluegill have been introduced and, although popular among anglers, can compete with or prey upon native fish. These are collectively referred to as "warm water" fish and their distribution in the Corvallis area is limited to the lower gradient or valley floor reaches of streams approaching a confluence with the Marys or Willamette Rivers.

Of greatest concern are species sensitive to habitat change or whose numbers have already declined from historic levels. Oregon chub, a small minnow-like fish once common to backwaters and sloughs along the Marys and Willamette Rivers, is now federally listed as endangered. Although no existing population of chub has been documented in Corvallis, this area is within the species' historical range and a small population does currently exist in Muddy Creek, a tributary of the Marys River, which is a short distance upstream from Corvallis.

The decline of salmonids is more widely recognized in Oregon and the Willamette Basin. Over the past few decades, several species of salmon, trout, and steelhead have been found in this area. Those native to this area are spring Chinook salmon, cutthroat trout, and rainbow trout. Winter steelhead is also native to the upper Willamette, but the nearest basins in which they are found are the Luckiamute and Calapooia. Other salmonids, such as summer steelhead, fall Chinook salmon, and Coho salmon, were introduced by hatchery programs.

Upper Willamette spring Chinook salmon, currently listed as threatened under the federal Endangered Species Act, also use Corvallis streams for rearing juveniles. Adult spring Chinook migrate through the Willamette River past Corvallis on their way to Cascade Range river basins such as the McKenzie River, where they spawn. Juvenile Chinook, however, can migrate downstream early in their lives and are commonly found throughout the year in the Willamette River. As flows increase during the fall, winter, and spring, juvenile salmon will migrate into the Willamette River's tributaries, including those in the Corvallis area, seeking refuge or better rearing conditions.

All Corvallis-area streams support native cutthroat trout. Willamette cutthroat trout are not currently listed as threatened or endangered by the State or federal government, but are considered a "stock of concern" by the Oregon Department of Fish and Wildlife because of habitat loss. Resident trout populations are found in streams where the year-round water quality is capable of supporting their cool-water needs. These are generally confined to the upper reaches of Oak Creek, Dixon Creek, or the Jackson/Frazier basin. All streams, however, support fluvial populations of cutthroat trout on a seasonal basis. Fluvial cutthroat trout migrate between the Willamette River and its tributaries. Adults use the higher gradient reaches of area streams for spawning. The juvenile fish use the entire lengths of these systems for seasonal rearing, typically occurring in greatest numbers during the fall, winter, and spring, when the water quality can support them.

The Corvallis watersheds support an array of animals. Examples of large animals that can be found within the upper reaches of the watersheds include black bear, elk, and deer. Examples of smaller animals that are typically found within the lower reaches or streamsides include cougars, coyotes, beavers, mink, and otter. A variety of birds can be found throughout the area, with the majority of migratory species preferring the lowlands and floodplains.

4.1.8 Stormwater Conveyance System

Most of Corvallis has a stormwater conveyance system that is separate from the sanitary sewer system. Stormwater flows via pipes or over land into the nearest stream, which then flows into either the Willamette or Marys Rivers. The exception to this is the older, downtown area. Here, both stormwater and sanitary flows are carried by the same pipes in what is called a combined sewer system. During typical rainfall events, the stormwater runoff and sanitary wastes are conveyed to the Wastewater Reclamation Plant for treatment before discharging into the Willamette River. During extreme rainfall events, some of the combined flows may discharge directly to the river, causing pollution problems. The City has made improvements to the combined sewer system, virtually eliminating the potential for untreated sanitary flows to reach the river. The improvements were fully implemented as of December 31, 2000.

4.1.9 Existing Effects of Urbanization

Many of the observed stream conditions in Corvallis are typical for an urban environment that contains large amounts of impervious areas. Studies of urbanization have shown dramatic increases in the peak flows and volumes of runoff generated from increased impervious areas. Flood levels and the rate of erosion increase in conjunction with urbanization. Channels become deeper and are no longer connected to their floodplain. There is less variety in stream conditions, which results in decreased habitat value for fish and wildlife.

A number of studies in the Puget Sound area have found that stream ecosystem impairment begins at about 10 percent imperviousness (Booth and Jackson, 1997; May et al., unpublished; Horner et al., 1996). It has been estimated that typical suburban development in the Pacific Northwest has 90 percent less storage capacity than the trees and soil of the coniferous forest (Wigmosta et al., 1994). Stormwater best management practices have the potential to recover only about 25 percent of this lost capacity (Barker et al., 1991).

Loads of sediment, petroleum hydrocarbons, metals, nutrients and other pollutants are also higher in developed areas. This further decreases the natural habitat value of the streams and riparian areas.

4.1.9.1 Drainage and Flood Issues

Corvallis has a long history of flooding. The largest flood recorded occurred between November 28 and December 4, 1861. During this nearly continuous storm activity, rainfall and abnormally low temperatures led to saturated soils and a large snow pack. When a large storm system with warmer temperatures began on November 28, the rain and melting snow led to an estimated river elevation of 32.4 feet at Corvallis, which would have flooded most of the downtown area. Other large flood events of February 1890 and December 1964 echoed the pattern of saturated soils and abnormally low temperatures followed by a warm front with heavy rain. The event of February 1996 also followed this pattern and caused widespread flooding in the Corvallis area, although dams built along the Willamette River during the 1960s and 1970s kept damage from being even greater.

Flooding from the Willamette and Marys Rivers will continue to be an issue when climatological conditions occur that are similar to those above. This type of flooding is difficult to prevent. However, other recent flooding events have been caused by high stream flows, not from the backwater effects of the Willamette and Marys Rivers. These include flooding near Arthur Circle, Lancaster Avenue, and Knollbrook Place in February 1996, November 1996, and December 1998, respectively.

City staff has noted roads that were flooded during the February 1996 storm. Flooding occurred in several parts of the City, except the northwest hills. Flooding locations have been noted in Chapters 6 through 13 for the individual basins.

4.1.9.2 Water Quality

Development within a watershed can contribute to water quality problems. Pollutants are carried by stormwater from upland areas into receiving waters. Increased flows within the conveyance system may cause erosion of stream banks or resuspension of deposited sediments. Removal of trees leads to increased stream temperatures, which decreases dissolved oxygen in the water. All of these water quality effects reduce habitat value and may even pose human health risks.

Water quality information is limited within the study area. The City performs monthly testing for *E.Coli*, pH, and dissolved oxygen in order to detect sources of pollution to Corvallis streams. The City assembles this data into an annual report made available to the public. No monitoring is done for chemicals that regulators consider priority pollutants, such as metals or nutrients. Data from other sources must be used to extrapolate the potential for water quality problems in the area.

Table 4-5 lists compiled information on pollutant concentrations in stormwater runoff from Willamette Valley monitoring sites. The information indicates that pollutants are lowest in open, undeveloped areas and highest in places with large impervious areas and elevated levels of vehicular traffic. The pollutant concentration for a given land use would be multiplied by the runoff volume from that land use to calculate the mass load of pollutants entering the conveyance system.

Table 4-5. Water Quality in Runoff from Willamette Valley Sites (mg/L)

Land use	Total suspended solids	Total phosphorus	Total copper	Total zinc
Industrial	194	0.633	0.053	0.629
Transportation	169	0.376	0.035	0.236
Commercial	92	0.391	0.032	0.168
Residential	64	0.365	0.014	0.108
Open	58	0.166	0.004	0.025

Source: Association of Clean Water Agencies, 1997

Land uses highest in pollutant concentrations also tend to be highest in imperviousness, and thus, runoff. They have a disproportionate impact, per acre, on water quality. Concentrating pollutant reduction efforts to commercial, industrial, and institutional users often gives the greatest pollutant reduction per dollar spent. However, other land uses cannot be ignored because they often cover greater areas. Future residential land use is projected to cover roughly four times the area projected for industrial use. Also, construction sites can be a major source of total suspended solids.

4.1.9.3 Erosion and Sedimentation

Erosion and sedimentation are naturally occurring processes that are unnaturally accelerated by land development. Soils denuded of vegetation and the resultant increased imperviousness are two potential effects of development that contribute to greater peak flows, longer duration of high flows, and other factors that increase erosion. Eroded material is often deposited downstream where it decreases culvert and channel capacity and smothers natural habitat.

The risks of erosion are highest in areas with fine soils, on steep slopes, and areas undergoing active construction activities. Several areas in Corvallis meet this definition, especially to the west and northwest.

4.2 STORMWATER PLANNING WATERSHEDS

This section briefly describes the physical characteristics of each of the major drainage basins. Chapters 6 through 13 provide a more detailed account of the hydrologic/hydraulic modeling results and the recommended projects and management procedures for addressing the deficiencies within each watershed.

4.2.1 Dixon Creek

The main drainage of this 2,712-acre watershed is through Dixon Creek. The North Fork originates in the hills near Chip Ross Park and the South Fork originates on Dimple Hill. The two branches join near 29th Street. From there, Dixon Creek runs about 2.6 miles and empties into the Willamette River near the Corvallis Wastewater Reclamation Plant.

Most of the watershed has already been developed with predominantly residential land use above 9th Street and commercial land use below. The open areas are located mainly in the upper reaches of the watershed, and are currently undergoing development. Future land use shows complete development of the upper reaches of the watershed to low-density, single-family residential.

4.2.2 Squaw Creek

Squaw Creek has two main branches, both over 2.5 miles long. The northern branch, originating at Bald Hill Park, and the western branch, originating near the junction of West Hills Road and Reservoir Avenue, come together just upstream of 35th Street, after which they flow less than 1 mile to their junction with the Marys River.

The creek drains almost 2,400 acres of relatively flat land. The flat topography has resulted in a number of wooded wetlands along the creek. Some of these have been preserved as part of the open areas of Starker Arts Park and the Sunset Park ball fields. The eastern part of the watershed has been developed as low-density residential. The western part is now being developed to a higher density residential.

4.2.3 Jackson/Frazier/Village Green Creeks

The Jackson, Frazier, and Village Green creeks form a complex network of streams and wetlands to the north of the Corvallis city limits. Jackson and Frazier creeks both originate in McDonald State Forest. The two flow eastward through the state forest before merging at Highway 99. East of Highway 99 their combined flow enters the Jackson-Frazier Wetland, an important habitat area. The flow leaving the wetland is split between the farmlands to the northeast and Village Green Creek to the south. Village Green Creek runs over half a mile to the southeast before joining Sequoia Creek.

The Jackson Creek portion of the watershed contains over 1,500 acres, and the Frazier Creek portion contains over 2,200 acres. Both creeks are located in largely rural areas, with forests in their upper reaches giving way to agricultural fields in the lower, flatter portions. Development has been limited mainly to housing along a number of the stream reaches. Roughly two-thirds of the 380 acres that drain to Village Green Creek are developed as residential.

4.2.4 Sequoia Creek

The Sequoia Creek watershed is located in northern Corvallis. The creek runs about 3 miles southeast and then east from Chip Ross Park to its junction with Village Green Creek. The combined creeks run eastward through Stewart Slough and ultimately discharge into the Willamette River. The watershed's headwaters are steep and many are piped, and the stream is relatively narrow once its grade flattens out west of 9th Street.

Residential land use constitutes about half of the watershed's almost 1,400 acres, but significant commercial and industrial properties are concentrated in the stream's lower reaches. The lower reaches are also where some of the best habitat is located.

4.2.5 Garfield Basin

The Garfield watershed lies between the Dixon Creek watershed to the south and the Sequoia Creek watershed to the north. The small watershed, less than 350 acres, does not have year-round stream flow. Above Highway 99, storm flows are piped through an almost completely developed area, much of it commercial. Below Highway 99, only limited development has occurred. The flat topography and high groundwater table are the reasons for the large amount of wooded wetlands found in this downstream area.

4.2.6 Oak Creek

The Oak Creek watershed contains 8,300 acres, the largest watershed within the study area of the SWMP. The stream's headwaters are located northwest of Corvallis in McDonald State Forest. The creek follows Oak Creek Drive to the intersection of 53rd Street and Harrison Boulevard. Downstream of Harrison Boulevard, the creek flows through pastures and by farm buildings and research facilities owned by Oregon State University until it reaches the main campus. Oak Creek then flows through a short residential section south of the campus before flowing under Highway 20/34 and entering Marys River.

The largest current land uses include forest (about 6,000 acres) and agricultural (about 1,000 acres). Together they constitute over 80 percent of the watershed, and represent an opportunity to preserve or enhance currently undeveloped land. However, to accomplish watershed management, close co-ordination is required between Oregon State University, which manages both the forest and agricultural land, and Benton County.

4.2.7 Marys River

The Marys River watershed extends well beyond the borders of the study area. Only three small drainages containing a total of 78 acres within the Corvallis Urban Growth Boundary (UGB) were included in this study. These drainages lie south of the Corvallis Country Club and flow southward down the hill and into the Marys River floodplain. Open space and low-density residential are the current land uses, but the area is undergoing significant development. In the future, low-density residential will cover 69 acres, and the rest preserved with an open-space conservation designation.

4.2.8 South Corvallis

The South Corvallis watershed lies on either side of Highway 99, south of the Marys River. Areas west of Highway 99 drain to the Marys River, while areas east of Highway 99 drain to the Booneville Slough and the Willamette River. The South Corvallis Drainage Master Plan (SCDMP) was completed in 1996 to address flooding problems, mainly in areas south of Goodnight Avenue (City of Corvallis, December 1998).

The current study addressed two drainage basins not included in the SCDMP: Millrace and Goodnight Avenue. Both basins are flat and prone to flooding. Existing land use in the 350-acre Millrace drainage basin is a mixture of residential, industrial, and undeveloped property. Existing land use in the 300-acre Goodnight drainage basin consists mainly of residential and undeveloped properties. Undeveloped properties in the Millrace drainage basin are expected to become commercial in the future. Undeveloped properties in the Goodnight Avenue drainage basin are designated as residential. A small, fully developed drainage area called Ryan Creek has seasonal flows that discharge into the Willamette Park area.

4.3 AREAS OUTSIDE THE CITY LIMITS

Figure 4-1 shows the boundary of the study area. The boundary is determined from topographic considerations completely independent from jurisdictional boundaries. As a result, the boundaries of most watersheds within the study area extend beyond the Corvallis city limits. The areas outside of the city limits and inside the UGB are scheduled for ultimate buildout but are not yet part of the City. As growth continues, these areas may ultimately be annexed into the City. Benton County has jurisdiction over areas outside the city limits as well as areas outside the UGB. Implementing watershed-wide stormwater management practices will require the cooperation of the City and Benton County.

CHAPTER 5

COMMUNITY-WIDE STORMWATER PLANNING AND POLICIES

5.1 INTRODUCTION

The Stormwater Master Plan (SWMP) is a departure from historical methods of dealing with stormwater runoff. It integrates the broader watershed and its functional elements and processes into stormwater planning and implementation. Streams that were viewed solely as water conveyance systems are seen as an integral part of the community's ecological health. A watershed is defined as the land within a given area (or basin) that collects rainfall towards a stream system. It includes the area from the ridge top of elevated areas to the confluence (or discharge) of the receiving stream, and both surface and subsurface water. The watersheds included in the SWMP are shown in Figure 4-1.

Planning by watershed is intended to provide a unified stormwater management strategy that will address water quality, water quantity, uplands natural resource and wetlands management, cross-jurisdictional basin management, floodplain management, and stream-system management. Public participation and information outreach are also important components of a community-based management process.

This chapter identifies stormwater-relevant findings, including state and federal regulatory guidelines, current City practices, and community values. Based on these findings, it provides stormwater policy direction, and describes strategies and practices for managing local streams and watersheds. The chapter is organized into the following sections:

Background - Provides the context of Corvallis stormwater management, including streams and the way in which the community would like to address stormwater management today.

Existing Planning Framework - Summarizes other City documents related to stormwater planning, policy, and implementation.

Stormwater Quality Management - Addresses stormwater quality issues, including pollutants in surface and ground water, sediment transport, and water temperature.

Water Quantity Management - Addresses how stormwater volume is managed within the Corvallis urban landscape, from rainfall and other sources, to the stormwater's ultimate discharge.

Uplands Natural Resource and Wetlands Management - Addresses the stormwater management values of uplands natural features and wetlands, and the implications of activities in these areas.

Cross-Jurisdictional Basin Stormwater Management - Addresses watershed issues that cross-jurisdictional boundaries, including flow, water quality, wetlands, and stream vitality.

Floodplain Management - Addresses the functional value of floodplains and the implications of encroachment into them, and provides guidance for activities within floodplains.

Stream System Management - Addresses various techniques available for managing streams and riparian areas.

Public Participation and Information Outreach - Describes what can be done to involve and inform the community about individual and community-wide practices to improve stormwater management, including water quality, detention, and stream health.

Process for Implementing Policy Recommendations - Includes specific recommendations on implementation of this chapter's policy recommendations.

5.2 BACKGROUND

Like many northwest communities, Corvallis initially collected urban runoff and domestic sewage in the same piping system, called a combined sewer. The combined wastewater was then piped directly into the Willamette River. The City's first wastewater treatment system was constructed in 1952. The original facility had limited capacity and, by today's standards, the wastewater received little or no treatment, depending on rainfall intensity. As the river became increasingly polluted, the need for more intensive treatment of domestic and industrial wastes was met with sophisticated biochemical treatment. The cost per gallon of such treatment was expensive and it became economically prohibitive to continue treatment of storm runoff. Corvallis embarked on a program of sewer-storm separation, dedicating much of its combined sewer system exclusively to domestic waste, and routing stormwater to nearby drainageways or native streams.

When Corvallis introduced system development charges (SDCs) in the 1970s, stormwater conveyance was excluded. This decision marked the end of publicly funded stormwater pipes. Since that time, Corvallis has become increasingly dependent on its native streams and drainageways for conveyance of urban runoff. In 1981, Corvallis formally acknowledged that streams had, in fact, been transformed into the principal stormwater conveyance system, resulting in the City's first Stormwater Master Plan.

In the recent past, urban streams were managed solely as stormwater conveyance systems. This approach led to a decline in stream water quality, loss or decline in the diversity and abundance of aquatic and riparian species, and degradation of the physical condition of streams. It is now understood that, if managed appropriately, the streams passing through a city can provide numerous amenities to the community, including natural hydrological management such as the reduced potential for flooding, protected or restored habitat for aquatic and riparian species, improved water quality, green belts, open spaces, educational opportunities for citizens, and increased property values for abutting property owners.

In the early 1970s, the State and federal governments established regulations protecting wetlands and the water quality of streams. Although these regulations were responsible for a number of improvements, the health of local waterways continued to degrade. Recently, new federal regulations were adopted to help further protect and improve streams, rivers, wetlands, and other natural habitats of our community. These new regulations require that local governments take a more active role in protecting water quality and certain species of fish and wildlife, and their habitats.

The City determined that the community was interested in updating the Stormwater Master Plan. In response to this concern, the Mayor appointed a Stormwater Planning Committee (SWPC) to work with the citizens and public agencies to undertake this effort. A variety of citizens provided direction on issues related to local stormwater management during the development of the SWMP. An initial random telephone survey (366 respondents) and stakeholder interviews (50 respondents) were conducted to assess citizen attitudes and values on elements of stormwater management. The respondents placed a high priority on improved stormwater management, such as better water quality, flood mitigation, wetland protection, and stream corridor vitality. The survey and interview questions, along with the results of both, are in Appendix A.

Additional citizen input was collected through a series of community public meetings and workshops hosted by the SWPC. The first three meetings focused on collecting citizens' issues, values, and objectives, and developing a set of stormwater evaluation criteria, which became the guiding principles for stormwater management. Citizen input was also collected for each basin within the Urban Growth Boundary (UGB) during a series of 10 meetings hosted by the SWPC. Two workshops were then held to collect citizen input specific to watershed management, including alternatives for floodplain regulations and stream corridor width, water quality, detention, and stormwater management from a watershed-wide perspective.

The comments and responses of citizens were reviewed by the SWPC to identify specific stormwater policy issues. The SWPC considered a range of policy alternatives to address these issues. The stormwater policy direction and suggested strategies and practices in the SWMP are a result of this community-wide process. The results of the public meetings and the policy alternatives considered by the SWPC are summarized in Appendix A.

To meet regulatory requirements and address citizen input, a watershed-based approach to stormwater management was used. This approach considers the diverse needs of the community, government regulations, and environmental implications. The City is in a unique position to provide watershed management leadership, since the City is responsible for numerous activities that affect the health of the watersheds. The City and the community acknowledge that this approach is necessary and, through the implementation of the SWMP, intend to preserve and restore these watershed functions for the benefit of current and future generations.

Community outreach efforts were conducted to develop a set of criteria by which the SWPC could evaluate the various options being considered. The following criteria were established and used in their evaluation of these options. Examples to aid in the clarification of these criteria are in Appendix A.

- Maintains and accommodates natural hydrological processes.
- Protects and improves water quality.
- Controls unwanted erosion.
- Protects and restores natural resources and ecosystem functions.
- Meets or exceeds current regulations and anticipated future regulations.
- Ensures that cost considerations are inclusive.
- Addresses maintenance requirements and allows for maintenance access.
- Incorporates community awareness and information exchange.
- Addresses cumulative effects and off-site effects.
- Is designed and managed to avoid public health and safety hazards.
- Incorporates community amenities.

- Explores and uses innovative and low-technology approaches.
- Implements urban and rural land use objectives.

A significant portion of development within the Corvallis UGB results from public activities such as infrastructure development and building construction. Through infrastructure planning and construction, the City influences the locations of other public and private developments. For example, when a road is planned and built within a floodplain, the City encourages other construction within that floodplain.

The City has the opportunity to provide leadership by using highly responsible standards for its municipal development activities. The City can use its partnerships with other public entities, such as the county and school district, to encourage these public bodies to exhibit the same responsible activities in their construction, operation, and maintenance tasks. Policies outlined in the SWMP will apply to municipal as well as residential, industrial, and commercial development. The City will use its facility plans to provide the framework to encourage appropriate development in locations so as to preserve or enhance the flow and quality of the stormwater in its local watersheds.

5.3 EXISTING PLANNING FRAMEWORK

The SWMP provides the guiding framework and policy recommendations for managing watersheds and their associated waterways. The City also has a number of existing planning and engineering tools available for managing stormwater runoff and natural resources within the community. These tools include:

- Comprehensive Plan,
- Master Plans,
- Land Development Code,
- Municipal Code,
- Council Policy,
- Design Criteria Manual, and
- Standard Construction Specifications.

The relationships among these documents are described in the next sections. Altogether, these documents provide the City with the framework for managing stormwater and watersheds.

5.3.1 Comprehensive Plan

The Comprehensive Plan contains the requirements of the Statewide Planning Goals and Guidelines and the community's vision on land use. It defines how land will be used and managed within the City.

Generally, the Comprehensive Plan is organized around the topic areas defined by the Statewide Planning Goals. Each topic area is in an article (chapter) that includes a background discussion followed by findings and policies in support of the goals. The findings provide statements of fact or conclusions, while the policies provide guidance for actions required for meeting the community's vision. Master facility and area-specific plans for implementing the policies of the Comprehensive Plan are also included by reference as part of the Plan.

5.3.2 Master Plans

The City has developed master plans that address long-range planning within specific areas of service or interest. These master plans add greater detail to the policy direction provided by the Comprehensive Plan. For example, the *South Corvallis Drainage Master Plan* (SCDMP) was developed to address the specific drainage needs of that area of the City.

Other planning documents that influence stormwater and natural resource management include: South Corvallis Area Plan, West Corvallis/North Philomath Plan, Parks and Recreation Facilities Plan, Criteria and Process to Acquire or Protect Open Space, Water Master Plan, Wastewater Master Plan, and the Corvallis Transportation Plan. Since each of these documents was prepared with a different primary purpose, their effect on stormwater and natural resource management may not be consistent with contemporary watershed management.

5.3.3 Land Development Code

The Land Development Code (LDC) provides specific direction to implement the policies of the Comprehensive Plan and the associated Master Plans. It is one of several documents used by developers, interested citizens, and the City to ensure that new construction and redevelopment are consistent with the goals and policies of the City. It contains development standards for various land use designations, along with the legal framework, enforcement provisions, and administrative procedures for land development.

5.3.4 Municipal Code

The ordinances defined by the Municipal Code provide the legal framework for managing City operations and define procedures and responsibilities for many of the activities undertaken by City government. The Code contains sections on local improvements, utilities, traffic, public protection, and development regulations. Presently, the section on utilities focuses on the sanitary collection/treatment and water distribution systems. The Code is silent on stormwater management issues, except for title 2.09, which explains the financial charges for the stormwater utility.

5.3.5 Council Policy

As the City's governing body, the City Council uses numerous avenues to define policies. These avenues include special plans developed in response to specific needs, such as an Endangered Species Act (ESA) Response Plan, budget authority as exercised through the annual City budget and the Capital Improvement Plan, and agreements with other jurisdictions governing joint activities. The Council can also develop policies that provide direction for the day-to-day operations of City government, such as maintenance procedures, recycling, and chemical use in landscaping. Examples are the Drainageway Maintenance Plan and the Integrated Pest Management Plan.

5.3.6 Design Criteria Manual

The 1991 Design Criteria Manual defines minimum engineering criteria for the design of public infrastructure including streets, and water distribution, sanitary sewer collection, and stormwater collection systems. For example, it specifies that new storm drains shall be designed to handle a 10-year event storm.

The Design Criteria Manual discourages the use of detention facilities, although the City has required their use in recent years for private development projects. In addition, the manual does not specify the use or design of facilities to protect water quality. Currently, the manual states that inspection and maintenance of private stormwater detention and treatment facilities are the responsibility of the owner(s).

Brown and Caldwell wrote an Interim Technical Memorandum, *Recommendations to Development Standards*, June 15, 1999, that specifically addresses new stormwater design practices. The memorandum discusses the rationale for modifying sections of the Design Criteria Manual and provides recommended language that could be adopted for it. The recommendations include requirements for detention and water quality facilities. This technical memorandum is in Appendix F.

5.3.7 Standard Construction Specifications

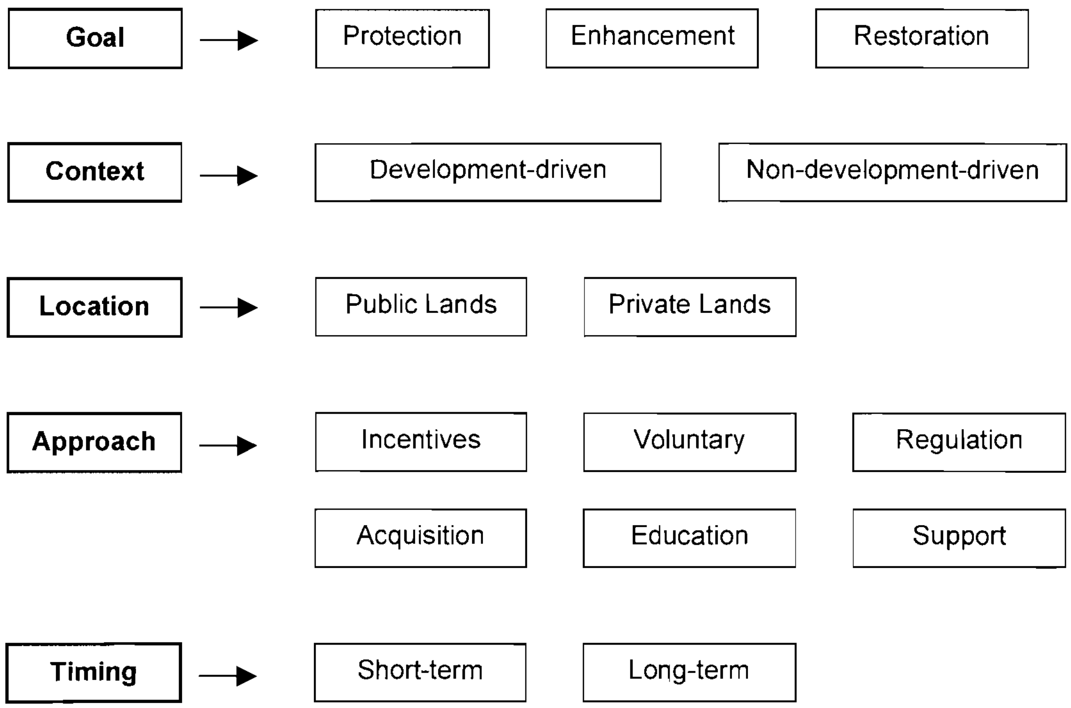
The Standard Construction Specifications (SCS) provide guidance on the design and construction of all public works projects within the City, including streets, sanitary sewers, water lines, and storm drainage systems.

5.4 WATERSHED AREA STORMWATER MANAGEMENT

In the following sections, each management issue is discussed in detail and includes background, issues, and citizen input that frame solutions to watershed management goals. These are followed by strategies to address the issues and specific policies and programs suggested to improve stream functions and stormwater management. This section also includes suggested follow-up actions that will be required to more fully address the issues.

Figure 5-1 summarizes the options and implementation strategies that were considered during development of the plan and the policies.

Figure 5-1. Stormwater Policy and Implementation Strategies



5.4.0 General Policies

GP-1 The Corvallis stormwater utility shall incorporate existing natural features such as streams and wetlands as a means of managing urban runoff. When using these natural features for urban stormwater needs, stormwater management shall follow the guiding principle of minimizing harm to these natural systems, maintaining the natural functions and, over time, repairing any damage associated with past practices.

GP-2 Implementation of the Corvallis Stormwater Master Plan shall be guided by the following evaluation criteria:

a. Maintains and accommodates natural hydrological processes.
b. Protects and improves water quality.
c. Controls unwanted erosion.
d. Protects and restores natural resources and ecosystem functions.
e. Meets or exceeds current regulations and anticipated future regulations.
f. Ensures that cost considerations are inclusive.
g. Addresses maintenance requirements and allows for maintenance access.
h. Incorporates community awareness and information exchange.
i. Is designed and managed to avoid public health and safety hazards.
j. Incorporates community amenities.

k. Minimizes cumulative effects and off-site effects.
l. Explores and uses innovative and low-technology approaches.
m. Implements urban and rural land use objectives.

GP-3 Policies outlined in the SWMP shall apply to Municipal, Residential, Commercial, and Industrial (MRCI) development.

GP-4 The City shall recognize and use both short-term (up to 10 years) and long-term (10-100 years) implementation strategies to meet community stormwater objectives.

GP-5 The City shall develop a set of incentive mechanisms for potential use in implementing stormwater policies and encourage private property owners, non-profits, and other organizations to participate in their implementation.

GP-6 The City shall determine "beneficial uses" relevant to local streams within the Urban Growth Boundary and monitor whether these streams are meeting their beneficial uses.

5.4.1 Stormwater Quality Management

5.4.1.1 Background

Human activities can degrade water quality. Impervious surfaces such as roads and parking lots collect oils and other materials that are transported into streams during rainstorms. Farming and development activities disturb historical vegetative cover, often resulting in the transportation of sediments into waterways. The application of chemicals by farmers and homeowners has also affected the chemistry of the water in the streams.

Corvallis citizens highly value the health of the City's streams, wetlands, and groundwater. In addition, a number of State and federal regulations were developed to improve or protect the quality of stormwater runoff and receiving waters. The Oregon Department of Environmental Quality (DEQ) has conducted studies and analyses that identify elevated temperature levels or concentrations of bacteria and toxins in Oregon streams and rivers. The DEQ has determined that the Corvallis section of the Willamette River is "water-quality limited" for temperature, bacteria, and mercury. (Water-quality limited streams do not meet water quality standards for a particular parameter such as mercury.) The Marys River near the confluence of the Willamette is water-quality limited for temperature and bacteria.

There has been limited testing for contaminants in Corvallis streams, but City data have shown periodic elevated temperature and bacteria levels. For these reasons, stormwater quality is one of the important issues that must be addressed in the stormwater planning process. For example, a recent National Water Quality Assessment Program study (Anderson, 1997) showed high levels of pesticides in Dixon Creek.

The City does some stream monitoring that includes monthly sampling and testing for basic water quality parameters including bacteria, dissolved oxygen, pH, and temperature. The principal goal of the stream monitoring program is to identify sources of contamination in urban streams. When sources of contamination are located, City staff conducts follow-up activities to facilitate elimination.

A 3-square-mile area within the City limits has a combined sanitary and stormwater collection system that conveys stormwater runoff to the wastewater treatment plant. The combined system serves some of the more densely developed and impervious areas of the City, including the downtown area. The stormwater collected in this area is treated to remove oils, grease, and suspended solids, and is chlorinated and then de-chlorinated. This level of stormwater treatment exceeds all present state and federal regulations as well as the National Pollutant Discharge Elimination System (NPDES) Phase II Stormwater Regulations.

The Oregon DEQ issues erosion control permits for construction activities on sites greater than 5 acres. The City also has regulations and requirements to control erosion from construction activities. City staff is responsible for review and approval of erosion control plans, issuance of permits, and monitoring and enforcement compliance. The objective of the erosion control permit program is to prevent construction activities from negatively affecting stormwater quality and natural resources.

The City has on-going maintenance activities that protect stormwater quality. All City streets are swept bi-weekly and catch basin sediments are removed yearly to help prevent pollutants and sediments from reaching streams.

5.4.1.2 Issues

By the year 2006, existing State and federal regulations will require greater levels of stormwater pollution source-control and prevention for the area of the City that currently has separate sanitary and stormwater collection systems. The types and levels of pollutants in urban stormwater and streams were well documented by studies of urban areas in Oregon. The Association of Clean Water Agencies (ACWA) is an organization of municipalities that shares common water quality goals in Oregon; the City of Corvallis is a member. In 1996, ACWA surveyed member-agency stormwater quality monitoring data to develop a profile of "typical" urban stormwater pollutants. The results of this survey were incorporated in the DEQ stormwater quality management regulatory programs and recommendations of Best Management Practices (BMPs) to control stormwater pollutants.

The federal Clean Water Act is the basis for most water-quality related legislation, including the National Pollution Discharge Elimination System (NPDES) program and the State-implemented Total Maximum Daily Load (TMDL) requirements. The City is considering additional water-quality related requirements as part of the Endangered Species Act (ESA) to protect federally listed aquatic species in the Willamette Basin. Each of these regulations is discussed in detail in Chapter 3.

The City will be required to establish programs and resources to meet the NPDES Phase II Stormwater permit requirements on or before 2006. The NPDES Phase II program requires six minimum controls for Phase II permittees. Three of the controls directly affect stormwater quality: illicit discharge detection and elimination, construction site runoff control, and post-construction runoff control. As a Phase II permittee, the City is required to develop and implement BMPs that satisfy each of these minimum control measures.

The State TMDL requirements are specific to certain water-quality related parameters or criteria. For example, stream temperatures are elevated during the summer and exceed water quality standards in sections of the Willamette River and in the lower reaches of the Marys River. Bacteria in the Willamette River exceed standards, and elevated concentrations of mercury have been found in fish tissue. Each of these parameters has made the DEQ 303(d) list. The 303(d) list is part of a national EPA program to identify water-quality limited waterways and the pollution components that affect water quality, such as phosphorus, ammonia, and nitrates. The City must work with the DEQ to develop and implement a plan to restore and protect the beneficial uses of local streams and rivers.

Compliance with the ESA will affect many City activities, including public works projects and construction activities. Any activity that affects water quality and quantity, or the habitat of species listed under ESA, falls under the ESA requirements. Activities that result in erosion, use of chemicals (herbicides, pesticides, and fertilizers), and/or activities that affect riparian areas and wetlands must be scrutinized to determine the potential effects on listed species. Activities that have the potential to harm threatened or endangered species must be modified or eliminated. The City has initiated a separate work effort to determine the City's ESA Response Plan. Many elements of this SWMP were created with the ESA regulations in mind and will be an important component of the City's ESA Response Plan.

Although the City is responsible for complying with State and federal environmental regulations, private property owners are not always held to the same standards. Private property owners may affect streams or wetlands by encroachment, by removal of critical vegetation, or by the improper application of yard chemicals. These activities are often difficult to manage, as many citizens are not aware of the regulations that apply to their property, or are unaware of the detrimental effects that their activities have on a stream or wetland.

5.4.1.3 Citizen Input

Public input on policy development was received through public meetings held by the SWPC, a random telephone survey of residents, and stakeholder interviews. A telephone survey of 366 residents established a baseline of public opinion and identified public sentiment toward the management of stormwater in Corvallis. (See Appendix A for detailed survey results.) With regard to water quality, Corvallis residents clearly understand the importance of managing stormwater to protect the environment. Controlling surface pollutants entering streams received the highest "very important" rating (62 percent) of all issues reviewed, and a combined "very important" / "important" rating of 93 percent. Additionally, 52 percent of those surveyed say improving stream water quality is "very important" for future stormwater management planning, with a combined "very important"/ "important" rating of 92 percent.

Residents also consistently rate stream habitat as "very important." Fifty-six percent of those surveyed rate loss of stream habitat as "very important" with a combined "very important" / "important" rating of 88 percent. Sixty percent of the survey respondents say protecting stream habitat is "very important" in planning for future community stormwater management, with a combined "very important" / "important" rating of 94 percent. The importance of water quality is also underscored as residents rate less highly the option of using streams to drain urban runoff.

During public workshops conducted by the SWPC to develop stormwater alternatives, participants were asked to rate their support for water quality alternatives. Attendees were supportive of all alternatives that improved water quality. Over 80 percent of the participants supported voluntary measures and 70 percent supported mandatory standards. Participants supported alternatives to:

- Develop public infrastructure to provide for Best Management Practices for stormwater quality,
- Provide incentives to private construction that maintain stormwater quality, and
- Provide incentives to protect wetlands and riparian areas for their water quality benefits.

5.4.1.4 Strategies to Address Issues

The ACWA survey has been incorporated in the DEQ stormwater quality management programs and recommendations of Best Management Practices (BMPs) to control stormwater pollutants. BMPs include stormwater management techniques such as bioswales, surface detention ponds, and street sweeping. The City will be in compliance with NPDES Phase II regulations by applying the DEQ- recommended stormwater quality BMPs. The EPA has recommended BMPs for governing agencies to use for the control of stormwater quality issues for a range of contamination sources in the NPDES Phase II permit program. Additional, future water quality monitoring is recommended to confirm the success of stormwater quality BMPs.

Citizen interest in water quality and state and federal regulations suggest that the City would best meet the needs of the community by establishing policies to address state TMDL water quality standards for stream temperature and bacteria. Corvallis stream temperatures are monitored monthly, and exceed standards during the summer and fall when stream flows are low and ambient temperatures are hot. Direct sunlight on streams is a principal cause of increased stream temperatures and shading of the stream corridor is effective in controlling stream temperatures. Policies that support shading stream corridors are needed. Policies are also needed to support stream channel structure to create deeper pool habitat and provide cool refuge areas at times of low flows and warmer temperatures. Policies that promote groundwater contribution to base flows in streams and remove illicit stream flow diversions (typically for irrigation uses) will also help to control stream temperatures.

Bacterial contamination in streams can impair the safe use of the water body as a fishable and swimable stream. Policies that encourage BMPs for stormwater runoff that provide water quality treatment and reduced sedimentation will minimize bacteria in streams. Another common source of bacteria in streams is pet and other animal feces. Policies that control pet activities close to streams will address this source of bacteria. Policies should also address agricultural and other animal activities within or close to stream corridors. Controlling the sources of bacteria will reduce bacterial contamination of streams.

Another urban source of bacterial contamination is sanitary wastewater reaching streams via cross-connections between sanitary and storm systems. Operation and maintenance programs attempt to address elimination of cross-connections.

Compliance with NPDES Phase II and TMDL regulations will also assist the City in meeting ESA regulatory requirements. It is anticipated that the ESA Response Plan will require changes to City programs, operations and maintenance practices, maintenance standards, and development standards.

Protecting and improving the water quality of Corvallis streams represents an important value to the citizens of Corvallis. In response to the desires of the community, and as required by State and federal regulations, the SWMP establishes goals and policy recommendations to protect and improve stormwater quality. Also included are recommendations for follow-up actions.

5.4.1.5 Goals

1. Minimize soil erosion and sediment in stormwater.
2. Lower instream water temperatures.
3. Minimize pollution within waterways, groundwater, and wetlands.
4. Inform the public of the value of a healthy watershed.

5.4.1.6 Existing Policies

1. Where development of hillsides occurs, removal of vegetation will be minimized to control erosion. Vegetation disturbed during development shall be replaced or enhanced through landscaping (Comprehensive Plan Policy 4.6.9).
2. To minimize the negative impacts of development, stormwater runoff after development should be managed to produce no significant reduction of water quality than prior to development unless more appropriate provisions are identified in adopted comprehensive stormwater management plans (Comprehensive Plan Policy 4.10.6).
3. The City shall develop a program to minimize the conveyance of detrimental sediments and pollutants from public streets into streams and drainageways (Comprehensive Plan Policy 4.10.12).
4. The City shall attempt to protect groundwater resources from pollution and damage through education, regulation, and example (Comprehensive Plan Policy 4.12.1).
5. All development within the Corvallis Urban Growth Boundary shall comply with applicable State and federal water quality standards (Comprehensive Plan Policy 7.5.1).
6. The City shall work with the Oregon Water Resources Department to enforce illegal water withdrawals from streams (OWRD Regulation).

5.4.1.7 New Policies

QL-1 Sediment removal using Best Management Practices shall be used prior to discharge of all runoff from both public and private impervious areas.

QL-2 Lands set aside for water quality improvement, such as vegetated swales, detention facilities, and open channels, shall be maintained for proper functioning. Responsibility for maintenance shall be determined at the time these facilities are reviewed by the City for approval.

QL-3 To reduce the need for and costs associated with instream water quality monitoring, the City shall develop a program to monitor whether the stormwater quality policies are being implemented.

QL-4 The City shall develop a biological component for its instream water-quality monitoring program.

QL-5 The City shall work to ensure that harmful urban runoff is not discharged directly into streams.

QL-6 The City shall work to preserve and enhance native stream corridor vegetation on both public and private lands.

QL-7 The City shall work to limit stormwater pollutants from entering streams from sources such as agricultural waste, pet waste, vehicle wash water, household and business chemicals, and other community waste products.

QL-8 Along with the NPDES requirements, the City shall:

a. Require an erosion control plan for all construction activity that can potentially cause erosion.
b. Provide erosion control guidance to the development community in the form of an erosion control handbook.
c. Require sediment removal (to the maximum extent practicable) from construction site runoff prior to discharge to stormwater systems or streams.
d. Enforce erosion control measures through an active enforcement program with fines for violations, and educate the public and building inspectors on the importance of erosion control.
e. Develop community-specific standards that limit sediment discharge into receiving water bodies.

QL-9 The City shall develop guidelines for public agencies, private property owners, and landscape maintenance specialists that minimize the flow of chemical pesticides, herbicides, and fertilizers into the stream system.

QL-10 The City shall develop standards for cleaning publicly accessible parking lots and private catch basins that drain into public streams.

QL-11 The City shall continue cleaning public parking lots and catch basins.

QL-12 The City shall promote the protection of key areas of exchange between ground and surface waters, such as springs, unconstrained reaches of streams, and upstream drainages.

QL-13 The City shall prohibit new installations of overhead utility lines along streams where the utility is in conflict with management of vegetation that provides shading. However, utility lines may cross streams.

QL-14 The City shall promote the protection and enhancement of the stream channel structure for deeper pool habitat that provides cooler water refuge areas at times of low stream flows.

QL-15 The City shall continue to conduct cross-connection surveys to identify any sanitary or other illicit connections to the stormwater system.

QL-16 The City shall continue to evaluate, design, and modify its facilities to minimize known sources of water quality impairment.

5.4.1.8 Suggested Follow-Up Actions

1. The City shall investigate additional stormwater quality management techniques that are used by other agencies and implement them as appropriate.
2. The City shall retrofit catch basins to improve water quality.

5.4.2 Water Quantity Management

5.4.2.1 Background

Water quantity management addresses how stormwater is stored and conveyed from where it falls to where it ultimately is discharged into a receiving water body downstream of the City. Typically, with the current urban infrastructure, precipitation is managed in one of three ways: (1) It can travel overland as sheet flow to open-channel drainages, wetlands, or piped systems; (2) it can soak into the ground and, as subsurface flow, be intercepted and collected by sump pumps, tiling, etc., or migrate to an open channel; or (3) it can be intercepted and stored by vegetation, roofs, or other surfaces until it evaporates.

The open-channel systems include the numerous natural streams and manmade channels and ditches found throughout the City. The piped system includes the inlets, catch basins, and piped drainage system used to convey stormwater runoff.

The City operates and maintains the stormwater collection and drainageway system, and responds to emergency flooding issues, including capital improvement projects that address flooding concerns.

5.4.2.2 Issues

Flooding is a natural process that occurs in an open-channel system when the flow exceeds the hydraulic capacity of the channel and the floodplain is employed to temporarily store and transport this additional water. For flood policy and management purposes, this document distinguishes natural flooding from urban-created flooding. Natural flooding is typically the historical flooding patterns that occurred before the City was established. Natural flooding has many positive benefits, including creating and maintaining varied habitat for fish and wildlife, and transporting nutrients onto the floodplains.

Flooding can occur at natural and manmade constrictions, or be the consequence of higher flows associated with increased development and intensified by land uses that fill or isolate portions of the floodplain. Natural constrictions that can lead to site-specific flooding include debris jams, low channel gradients, and loss of channel cross-sections due to sediment buildup. However, channel structures such as wood jams create opportunities for temporary water storage within the stream corridor. Manmade constrictions within the natural channel systems are usually a result of undersized culverts or bridges, although other manmade structures such as utility piping and dams (for water extraction) can lead to backups and flooding. Shallow watercourses that have been channelized in low gradient areas can fill with sediment. For more discussion on flooding in natural channels, see Section 5.4.5, Floodplain Management, in this chapter.

Water quantity management in the piped system focuses on conveying and storing stormwater runoff with limited pipe surcharging and flooding. Surcharging is defined as water flowing under pressure and exceeding the normal carrying capacity of the pipe. Flooding occurs when surcharged water reaches ground level. Both surcharging and flooding occur when the flow exceeds the hydraulic capacity of the conduit due to undersized pipes, low gradients (pipe slope), downstream backwater effects, or a combination of these factors.

The primary regulations influencing water quantity management are the Endangered Species Act (ESA) and the National Flood Insurance Program (NFIP). For a complete overview of the applicable regulations, consult Chapter 3.

The ESA influences how stormwater is managed from a quantity perspective. To protect an endangered species, ESA requires that properly functioning conditions be maintained within the geographical range of the listed species. The National Marine Fisheries Service advises jurisdictions to evaluate how development will affect base and peak flows and to manage that development to avoid changing the natural stormwater runoff hydrograph.

Nationwide, the NFIP has a major influence on how water quantity and flooding are managed within urban areas. When Congress initiated the NFIP in 1968, its objectives were generally limited to controlling costs to all levels of government due to flood disaster relief. The NFIP did not (and does not currently) factor in erosion and sedimentation, hydrologic energy modifications, habitat implications, and isolation of citizens living in floodplain developments during an event. The NFIP is administered by the Federal Insurance Administration as part of the Federal Emergency Management Agency (FEMA). The NFIP insurance coverage is available only in communities that implement regulations to reduce the likelihood of future flood damage. Current building codes and development regulations conform to NFIP standards by restricting new construction within flood-prone areas to the floodway fringe (a subset of the floodplain).

To enter the NFIP program, a community must complete a detailed technical study of flood hazards. A floodplain study determines the elevations of floods of varying intensity and the floodway boundaries. This information is presented on a Flood Insurance Rate Map and Flood Boundary and Floodway Map. The community adopts and enforces regulatory standards based on these maps. Currently, the City's Comprehensive Plan and Land Development Code support the FEMA program.

The City's stormwater collection systems were designed to collect and convey runoff for up to the 10-year return, 24-hour storm event. This is the amount of precipitation that occurs in a 24-hour storm event that has a 10 percent chance of occurrence in any given year.

The Corvallis area open drainageways, including streams and rivers, have been modified extensively by human activities over the last 150 years. Historical descriptions of the Corvallis landscape in the *1850s Federal Land Office Original Survey Notes* and historical aerial photos of the Corvallis watersheds from the 1930s demonstrate that significant modifications and relocation of the natural watercourse system have occurred. Most channel modifications (channel relocation, piping intermittent water-courses, and floodplain and adjacent wetland filling) for many of the last 40 years were made to accommodate urban development and agricultural practices, and worked against accommodating and managing larger flood events.

The total peak runoff flow that results from a storm event is directly related to (1) the soil's capacity to infiltrate water (soil saturation will affect this); (2) the elevation of ground water relative to the surface elevation; (3) the amount of impervious area (roofs, pavement); and (4) the amount of land-scape storage capacity, including basin-wide vegetative cover, channel-floodplain connections, and detention pocket areas such as wetlands, depressions, and swales. Typical urban development results in an increase in impervious area that also increases the peak flow from a given storm event. Imper-vious areas on steeper terrain result in more rapid runoff and greater peak flow than impervious areas on flatter terrain.

The City currently requires new private developments to use detention to keep development runoff equivalent to pre-development levels for up to the 10-year storm event. Infrastructure designed to manage water quantity can be achieved at different scales, ranging from large detention basins that serve entire developments to single-residential-lot methods.

Urban-related modifications to the peak runoff that enters area streams and rivers can have an ad-verse effect on the health of the receiving stream. Increased peak flows or frequency of peak flows can increase bank erosion, sediment transport, and downstream flood potential. Detention of runoff is an important tool to minimize the negative effects of peak flows from urban areas. However, there are areas within the lower reaches of the Corvallis area watersheds where improperly designed detention can actually accentuate downstream peak flows and flooding. Discharge strategies are therefore important in controlling effects on streams.

5.4.2.3 Citizen Input

Public input on water quantity management was provided through public meetings held by the SWPC, a random telephone survey of residents, and stakeholder interviews. Based on the telephone survey of 366 residents, a large number have first-hand experience with flooding. (See Appendix A for detailed survey results.) Over one-third of survey participants (37 percent) say they are affected by flooding, and for most of these it has become a routine occurrence. Over three-quarters (78 per-cent) reported that they are affected by one or more flood events during wet years. Twenty-two percent of respondents who have experienced flooding report damage to their homes, basements, or garages.

During the public workshops conducted by the SWPC, participants were asked to rate their support for water quantity alternatives. Attendees were supportive of all alternatives that addressed water quantity issues. Participants supported alternatives to:

- Develop public infrastructure to provide for Best Management Practices for stormwater quantity,
- Identify and acquire significant areas for natural detention,
- Protect upland vegetation to maintain stormwater function, and
- Develop guidelines to reduce impervious area for parking.

5.4.2.4 Strategies to Address Issues

Basin characteristics have a significant effect on water storage and on the timing and amount of runoff that enters the streams. Most important is the amount of rainfall, impervious area, vegetation, the rate of conversion of groundwater to surface flows, and runoff that exists in the watershed. Drainages that support proper stream functions typically require a minimum amount of water during specific times of the year. This amount of water is called the base flow, which is the water necessary to support healthy stream functions. Although base flows and groundwater recharge are critical elements of stream functions, saturated soils associated with building foundations can create structural challenges for developers. Engineering practices encourage the removal of groundwater beneath buildings and roads in order to provide a stable base. Compaction of soils and de-watering methods such as foundation drains discourage groundwater recharge. To address these issues, the City should encourage a range of design options that meet the detention and groundwater recharge objectives.

Existing policies and new policies are intended to reduce the effect of urban-influenced peak runoff and reduce the potential for urban-related downstream flooding. In response to the desires of the community, and as required by federal and State regulations, the SWMP provides program and policy recommendations to protect and improve stormwater quantity. In addition, recommendations are identified for activities that require further follow-up actions before implementation.

5.4.2.5 Goals

1. Maintain and accommodate natural hydrological processes, from base to peak flows.
2. Encourage percolation of rainfall into the ground.
3. Increase vegetative cover to retain and slow stormwater release.
4. Protect downstream properties from urban flooding.
5. Minimize urban-related erosion.

5.4.2.6 Existing Policies

1. To minimize the negative impacts of development, stormwater runoff after development should be managed to produce no significantly greater peak flow rates than prior to development, unless more appropriate provisions are identified in adopted comprehensive stormwater management plans (Comprehensive Plan Policy 4.10.5).

5.4.2.7 New Policies

QN-1 Through engineering analysis, the City shall establish stormwater detention and release standards for new development and redevelopment that preserve or restore the properly functioning conditions of the receiving waters.

QN-2 The City shall develop guidelines and evaluate the need for public infrastructure that provides for temporary detention in areas primarily dedicated to other uses, such as parks and open space, parking, and streets.

QN-3 The City shall develop standards for detention facilities. These facilities shall be located outside of stream channels unless it can be demonstrated that the properly functioning condition of the streams is maintained.

QN-4 The City shall consider the amount of impervious surface when evaluating detention requirements and develop a policy to encourage groundwater recharge opportunities.

QN-5 The City shall consider incorporating detention capacity when replacing or retrofitting the storm drainage system.

QN-6 The City shall consider acquisition of land and easements for future detention facilities.

QN-7 The City shall require the use of appropriate detention to control peak flows and reduce the potential for downstream erosion, flooding, and impairment of natural stream functions.

QN-8 To reduce peak runoff from impervious areas and maintain pre-development flow regimes, the City shall work to adopt standards such as the following:

a. Minimize the proportion of each development site allocated to surface parking and circulation.
b. Minimize the average dimensions of parking stalls.
c. Use pervious materials and alternative designs where applicable, such as infiltration systems.
d. Modify setback requirements to reduce the lengths of driveways.
e. Promote the use of shared driveways to reduce impervious surfaces in residential development.
f. Promote disconnection of roof downspouts to reduce runoff into a piped collection system or the street and encourage storage for reuse.
g. Retain a larger percentage of vegetated area within all types of development to increase rainfall interception.
h. Pursue the use of retention and infiltration facilities where the soils are suitable to control runoff volume, peak flow, and to promote dry-season base flows in streams.
i. Develop subsurface storage as well as surface detention facilities.
j. Evaluate additional restrictions on cuts in hillsides, especially in areas with near-surface groundwater.

QN-9 The City shall modify standards for managing urban runoff to allow for innovative building/landscape designs if it can be demonstrated that the resulting performance is comparable to existing building standards.

QN-10 The City shall encourage practices that enhance groundwater recharge to maintain or increase stream flow during dry periods.

QN-11 The City shall differentiate between natural flooding and urban-created flooding regimes and allow for natural flooding to occur while minimizing urban-created flooding (see FP-1).

QN-12 The City shall develop water quantity maintenance practices that protect, enhance, and restore the vegetative canopy along drainageways.

QN-13 The City shall use maintenance policies that enhance the natural detention capacity and upstream storage capacity of urban streams, such as retaining vegetation and wood, and allowing beaver dams to remain instream.

QN-14 The City shall provide incentives to developers for incorporating existing vegetation and open spaces into permanent stormwater facilities.

QN-15 The City shall develop standards to manage surface flows on developed sites to increase the time it takes for the water to reach the stream, where applicable.

QN-16 The City shall incorporate detention and water quality features into public street and municipal parking lot rehabilitation projects.

QN-17 To manage stormwater drainage and provide direction for developing standards, the City shall establish parameters and/or objectives for allowing new development to use vegetated swales or open channels.

QN-18 The City shall encourage parking lots to be constructed of stable pervious surfaces that do not degrade groundwater quality.

5.4.2.8 Suggested Follow-Up Actions

1. Recognize that the best efforts to mimic natural peak flood volumes and frequencies will probably not entirely maintain pre-development flooding regimes. Therefore, the City should design appropriate stormwater infrastructure, such as stream corridor widths, to accommodate those changes, including destabilized and widening channels, changes in the erosion and deposition patterns, etc.
2. The City shall identify steep terrain and consider implementing development standards for reducing impervious surfaces in these areas.
3. The City shall identify the runoff from impervious upland areas that is necessary to protect hydrological and habitat functions of areas downstream and consider development standards that maintain appropriate flows.

5.4.3 Uplands Natural Resource and Wetlands Management

5.4.3.1 Background

Upland natural resources and wetlands are an integral component of the stormwater functions within the overall watershed. Upland natural resources are the natural features and areas outside of the stream corridor and the 100-year floodplain that influence stormwater function and management. They include uplands, wetlands, vegetation, swales, and groundwater zones. Natural and human activities in these areas have a significant influence on stormwater, including the downstream channel and riparian areas. The Division of State Lands and the Army Corps of Engineers are responsible for the review and enforcement of the laws that govern wetlands in Oregon. In the landscape, wetlands provide water filtration and storage, and they support a unique habitat for aquatic and terrestrial creatures.

5.4.3.2 Issues

Land-disturbing activities in upland and wetland areas affect the natural storage and flow of stormwater, including both surface and subsurface flows. Development alters the natural process of stormwater infiltration into the ground and the recharge of the water table. The reduced quantity of infiltrated water can affect water supply to streams and wetlands, particularly to base stream flows during summer low-flow periods.

Vegetative management in upland and wetland areas influences water quantity and quality. Vegetation, including shrubs and trees, intercepts and stores precipitation until it is evaporated, while ground cover reduces soil erosion and slows overland flow. Improperly designed or sited urban development, poor construction practices, and forest or agricultural practices can alter hydrologic processes, resulting in increased flows, erosion, instream sedimentation, water quality degradation, and habitat loss.

Disturbances to wetlands and natural swales also influence water quantity and quality. Changes to surface flows, including an increase or a decrease in water volumes, can alter the form and ecological functions of natural features.

Existing local regulations governing upland natural resource and wetland management are in City and County codes and policies. The NPDES Phase II Stormwater Regulations and the ESA requirements also influence a number of activities within this category, as do the State and federal cut and fill programs. The Division of State Lands and Army Corps of Engineers currently enforce wetland regulations in the City and County. Citizens in the community have expressed concern that the Division of State Lands has not consistently implemented State and federal wetland regulations, and feel that strengthening these regulations through local policy might help to promote and encourage their more effective implementation. See Chapter 3 for more details on these regulations.

5.4.3.3 Citizen Input

Public input on upland natural resources and wetland management was provided through public meetings held by the SWPC, a random telephone survey of residents, and stakeholder interviews. Respondents to the telephone survey stated that protection of wetlands is an important issue. (See Appendix A for detailed survey results.) Eighty-eight percent rated protection of wetlands as "important" or "very important." Stakeholders who were interviewed also rated protection of wetlands as an important value. This was one of the key issues included as part of the "community livability" value expressed by those interviewed.

5.4.3.4 Strategies to Address Issues

Management of upland natural resources and wetlands in urban areas can protect or improve the stormwater-related functioning of these areas and can protect the health of the downstream systems.

In particular, this includes upland wetlands and natural swales, vegetation, and groundwater. These features provide for surface and subsurface runoff storage and transport, water quality protection, and natural habitat connectivity. Maximizing the tree canopy in upland areas reduces the downstream effect of rainfall runoff by providing interception of rainfall.

In response to community values, and as required by federal and State regulations, the SWMP provides programs and policy recommendations for the upland areas to protect and improve stormwater quality and quantity. Also included are recommendations for follow-up actions.

5.4.3.5 Goals

1. Protect and enhance upland natural resources in order to maintain and re-establish hydrological functions and improve water quality.
2. Preserve and enhance biological functions of existing wetlands.
3. Maintain and accommodate natural hydrological processes.

5.4.3.6 Existing Policies

1. Consistent with State and federal policy, the City adopts the goal of no-net-loss of significant wetlands in terms of both acreage and function. The City shall comply with at least the minimum protection requirements of applicable State and federal wetland laws as interpreted by the State and federal agencies charged with enforcing these laws (Comprehensive Plan Policy 4.11.1).
2. Wetlands within the Urban Growth Boundary shall be identified and inventoried by the City or through the development process (federal regulation implemented through the DSL).

5.4.3.7 New Policies

UP-1 The City shall ensure that operation and maintenance practices protect, enhance, and restore upland natural areas and their functions and processes.

UP-2 The City shall identify upland natural areas and natural swales within the Corvallis Urban Growth Boundary (UGB) that provide important hydrological and habitat functions.

UP-3 The City shall develop stewardship guidelines that protect natural stormwater functions and processes associated with wetlands, natural swales, and vegetation.

UP-4 The City shall encourage the Division of State Lands to fully implement and enforce wetland protection goals and regulations within the City and the UGB to maintain hydrological and natural resource functions.

UP-5 The City shall develop and implement incentives for developers and property owners to protect, enhance, and re-establish wetlands, natural swales, vegetation, and groundwater for stormwater functions.

UP-6 The City shall explore opportunities to acquire lands to preserve stormwater functions through outright purchase, conservation easements, and partnerships.

UP-7 The City shall encourage wetland mitigation to occur in the same basin.

UP-8 Wetland mitigation should not compromise the existing stormwater functions of the land being used for the mitigation.

UP-9 New development and redevelopment shall not significantly impair the quantity and quality of water reaching wetlands.

UP-10 The City shall place a high level of significance on wetlands that are adjacent to streams.

UP-11 The City shall continue to inventory significant habitat and natural resource areas.

UP-12 The City shall continue to maximize preservation and restoration of existing upland natural resource areas and wetlands by use of development standards in the Land Development Code.

5.4.3.7 Suggested Follow-Up Actions

1. The City shall consider exceeding existing state and federal requirements for wetland protection.

5.4.4 Cross-Jurisdictional Basin Stormwater Management

5.4.4.1 Background

Most of the City's stream basins extend beyond existing City limits and the Urban Growth Boundary (UGB). In addition, all of the streams passing through the City originate within Benton County, outside the City limits. Some of the streams leave the City and pass back into the County before joining the Willamette River. To achieve many of the objectives presented in the SWMP, coordination is required between the City and Benton County. The City has an agreement with Benton County known as the Corvallis Urban Fringe Management Agreement (CUFMA), which outlines jurisdictional responsibilities within the urban fringe area (outside the City limits and within the UGB).

5.4.4.2 Issues

The flow, water quality, and vitality of the streams are influenced by activities conducted within the County, since the headwaters for many of the streams and wetlands lie outside the City. In particular, the City and Benton County should revise the plan for managing development within the urban fringe to incorporate the objectives of the SWMP.

5.4.4.3 Citizen Input

Public input concerning cross-jurisdictional basin stormwater management was provided through public meetings held by the SWPC. (See Appendix A for detailed public meeting results.) Many citizens recognized the need for coordination between government agencies to meet stormwater management objectives. Citizens, including those who live along watercourses downstream of Corvallis, also expressed concerns regarding water quality, water quantity, and stream health downstream of the UGB. A strong preference was shown for development of City and County agreements for stormwater management in the urban fringe. Citizen input also supported using a watershed-wide outreach approach to increase awareness regarding stormwater issues.

5.4.4.4 Strategies to Address Issues

A coordinated watershed approach to address stormwater management issues will include cooperative participation of the City and surrounding jurisdictions. In response to the desires of the community, and as required by state and federal regulations, the SWMP provides program recommendations to protect and improve stormwater quality. In addition, recommendations are suggested that require further follow-up actions before implementation.

5.4.4.5 Goals

1. Create and adopt a stormwater management program coordinated between the City and County.
2. Maximize citizen participation and understanding of cross-jurisdictional stormwater issues.
3. Identify stormwater objectives that are shared by the City, County, and public agencies.
4. Seek to manage watershed basins for stormwater functions, regardless of boundary lines.

5.4.4.6 Existing Policies

1. The City and County shall pursue the completion of mapping of floodplain and floodway (including the City's 0.2-foot floodway) within the UGB, or require this mapping through the development process (Comprehensive Plan Policy 4.8.4).
2. The City shall work with Benton County to adopt a cooperative program that implements standards for management of vegetation, such as removal of detrimental vegetation and preservation of beneficial vegetation along significant drainageways within the city limits and UGB (Comprehensive Plan Policy 4.10.10).

5.4.4.7 New Policies

CJ-1 The City shall work with other governing agencies to develop a basin-wide stormwater management approach with common goals and objectives.

CJ-2 The City shall develop cooperative agreements, watershed assessment tools, and mutually beneficial funding mechanisms with surrounding jurisdictions to protect streams, wetlands, and habitat throughout the entire watershed.

CJ-3 The City shall work with Benton County to update the Corvallis Urban Fringe Management Agreement to adequately address stormwater management issues. Surrounding counties may also be part of the basin-wide management strategy.

CJ-4 The City shall work with Benton County to encourage public participation and information outreach activities for all citizens within the watershed to further the objectives of the SWMP.

5.4.4.8 Suggested Follow-Up Actions

1. The City and County shall identify watershed protection and restoration opportunities that involve multiple agency and/or property owner partnerships.

5.4.5 Floodplain Management

5.4.5.1 Background

Flooding is a natural stream and river process that occurred before urbanization altered the landscape and drainage patterns. Floodplains accommodate and manage flows at times when water volume exceeds stream or river watercourse channel capacity. The City's Comprehensive Plan includes floodplains as a significant natural feature, and recommends that significant natural features be preserved or have their losses mitigated and/or reclaimed.

As urban areas expand, flooding typically occurs more frequently and with greater consequences. The floodplain must accommodate these hydrological modifications. The current City Land Development Code allows development within a portion of the floodplain, called the floodway fringe. The National Flood Insurance Program (NFIP) guidelines allow construction of new occupiable buildings in the floodway fringe provided they are elevated 1 foot above the base flood level. The guidelines also allow fill and/or flood proofing, depending on the type of structure. However, NFIP objectives do not factor in erosion and sedimentation, hydraulic energy modifications, habitat implications, and possible citizen isolation from services that can be associated with floodplain development. The February 2001 Draft Oregon State Goal 7 (Natural Hazards) suggests that local governments adopt floodplain measures that exceed the NFIP, including limiting placement of fill in the floodplain.

The City's Land Development Code implements NFIP and FEMA regulations by defining two flood zones:

> **Floodway** - Channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than 0.2 feet.
>
> **Floodway Fringe** - Portion of the 100-year floodplain outside of the floodway. This area may be developed under current policies.

5.4.5.2 Issues

Floodplains play a significant role within stream and river basins. Floodplains provide additional storage and transport capacity during larger storm events, reduce instream velocities and bank erosion, collect sediment, provide refuge and feeding areas for fish during floods, and increase the recharge of groundwater. The public is more commonly aware of the negative aspects of floodplain flooding, including property damage, effects on business and transportation, and health and safety risks. The City desires to implement a floodplain management strategy that will avoid placing development at flood risk, lessen land-use conflicts between floodplain hydrological function and urban development, protect floodplain hydrological function, and reduce the threat of urban-created flood damage to private property while maintaining many of the hydrological and other benefits associated with natural flooding. The placing of public infrastructure in or through a floodplain often encourages development within the floodplain. SWMP policies to address floodplain management are focused on preventing additional urban-created flooding while allowing for natural flooding.

Small stream systems are affected to a greater degree by local actions (floodplain modifications) than are the Marys and Willamette Rivers. However, fill in any floodplain can potentially create some risk of affecting adjacent and downstream properties.

For communities that wish to qualify for flood insurance, NFIP regulations require their local governments to implement measures to reduce the potential of property damage due to flooding. The federal government has also developed regulations to implement measures to protect and restore the viability of endangered species, to protect water quality, and to protect wetlands and waters of the State from the effects of dredging and filling. Each of these regulations will influence, at a minimum, how the City manages floodplains. For a discussion on current floodplain regulations, endangered species requirements, and NPDES Phase II Stormwater Regulations, see Section 5.4.2 or Chapter 3.

5.4.5.3 Citizen Input

Public input on floodplain management was received through a random telephone survey of residents and through public meetings held by the SWPC. (See Appendix A for detailed survey and public meeting results.)

In the telephone survey, many residents noted that they have had some experience with flooding, but most have not experienced property damage. A majority (84 percent) recognizes the importance of controlling development in floodplains. Recent citizen flooding experiences included not only localized floodplain inundation, but also flooded streets and other areas when surcharged stormwater pipes were not able to dispose of water to the receiving water bodies. Citizens also requested City action after residential yards in the floodplain were inundated during recent storm events.

During the public meetings, a number of citizens noted that it is not possible to eliminate flooding from the landscape. Many were concerned that averting flooding in one part of the watershed increases flooding in other areas. They also noted that many types of urban development in the floodplain could directly conflict with a primary function of floodplains: to accommodate and manage stormwater. The public also raised the issue of the cost to current landowners of restricting development in the floodplain. Some noted that the community should share these costs.

The SWPC also reviewed a range of floodplain development alternatives with the attendees at the public meetings. Feedback received from the workshops shows strong support for more restrictive standards for floodplain development. The following alternatives were presented to the participants:

Alternative A - Keep existing development standards. Development is allowed in the 100-year floodplain outside of the floodway, if elevated (on fill or without restricting flow), or flood-proofed.

Alternative B - No net fill in the 100-year floodplain outside of the floodway. Allows development, but filling must be offset with excavation at the site to maintain flood storage capacity.

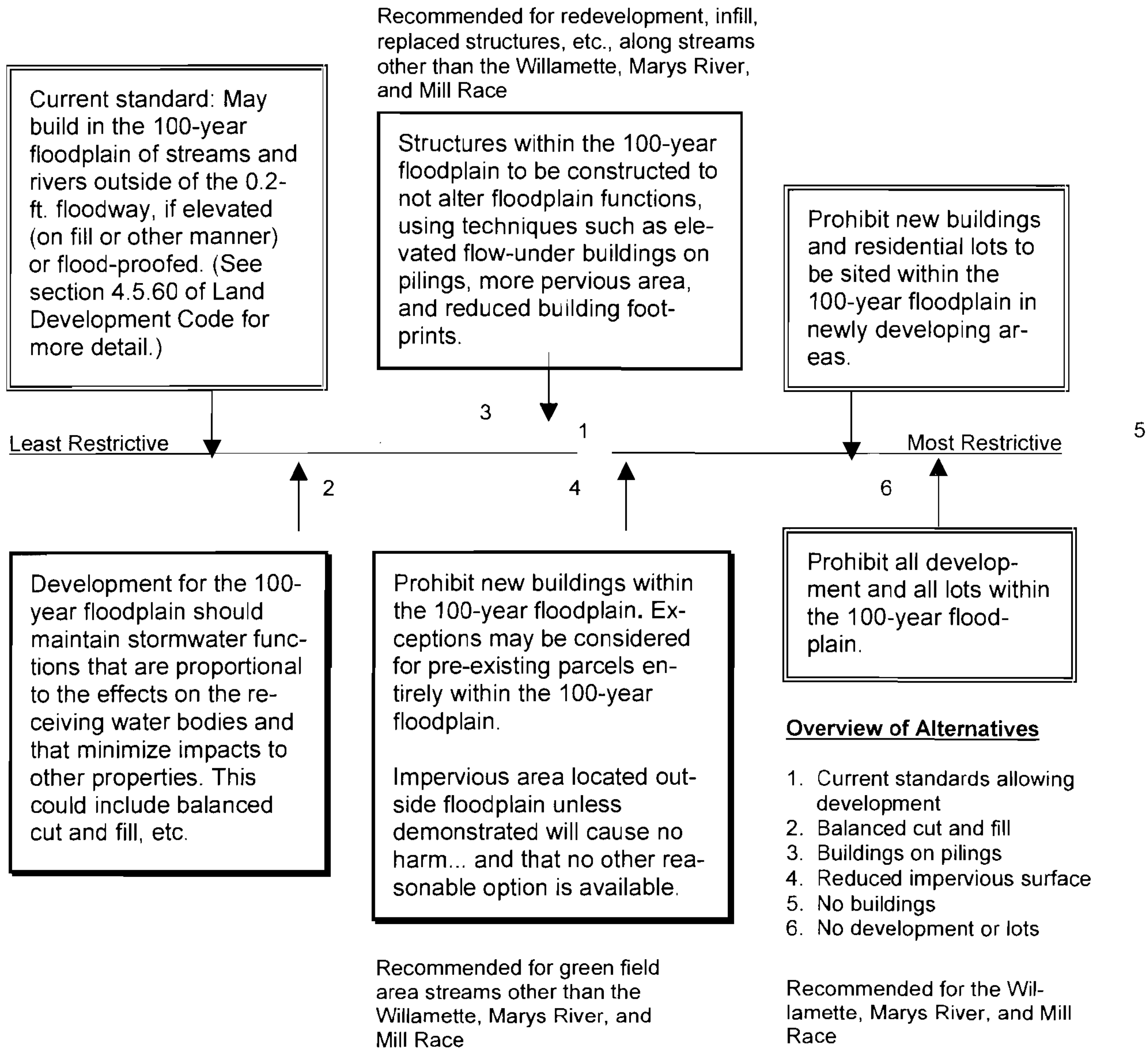
Alternative C - Allow construction in the 100-year floodplain outside of the floodway, but structures must be elevated to not restrict flow, i.e., without fill or other water-displacing design.

Alternative D - No structural development within the 100-year floodplain. Use density transfer to offset floodplain development constraints for residential areas.

Thirty participants rated these alternatives and indicated strong support for the more restrictive alternatives (B, C, and D).

Figure 5-2 shows the range of development alternatives that the SWPC considered, along with highlighting some of the recommended policies.

Figure 5-2. Development Alternatives



5.4.5.4 Strategies to Address Issues

Developing accurate mapping of the floodways and 100-year floodplains in the UGB will help determine which areas are at risk of flooding. This data will provide decision makers with a clear understanding of the flood potential and the threat to existing structures.

In response to the desires of the community, and as required by State and federal regulations, the SWMP provides policy recommendations to protect and improve the floodplain function and processes, including both the 100-year floodway and floodway fringe. In addition, recommendations are suggested that require further follow-up actions before implementation.

5.4.5.5 Goals

1. Manage the 100-year floodplain for floodwater storage and transport.
2. Discourage activities in the 100-year floodplain that jeopardize floodplain functions.
3. Protect and enhance water quality and habitat by maintaining natural processes and functions.
4. Restore natural flooding capacity along urbanized streams.

5.4.5.6 Existing Policies

1. The City shall conduct further studies on methods to protect natural resources from the negative effects of development, such as transfer of development rights, Open Space - Conservation districts, or other useful measures (Comprehensive Plan Policy 4.5.5).
2. Development shall be prohibited within the floodway, except for bridges, public utilities, and seasonal and other temporary water-related uses that do not significantly alter the patterns of floodwater flows (Comprehensive Plan Policy 4.8.3).
3. Significant natural features within the UGB shall be identified and inventoried by the City or through the development process. These shall include:
   a. Seasonal and perennial streams and other natural drainageways, wetlands, and floodplains;
   b. Lands abutting the Willamette and Marys Rivers;
   c. Land with significant native vegetation as defined in the *Oregon Natural Heritage Plan (1998)*, which may include certain woodlands, grasslands, wetlands, riparian vegetation, and plant species;
   d. Ecologically and scientifically significant natural areas;
   e. Significant hillsides;
   f. Outstanding scenic views and sites; and
   g. Lands that provide community identity and act as gateways and buffers (Comprehensive Plan Policy 4.2.1).
4. Natural features and areas determined to be significant shall be preserved, or have their losses mitigated and/or reclaimed. The City may use conditions placed upon development of such lands, private nonprofit efforts, and City, State, and federal government programs to achieve this objective (Comprehensive Plan Policy 4.2.2).
5. The City and County shall pursue the completion of mapping of floodplains and floodway (including the City's 0.2-foot floodway) within the UGB, or require this mapping through the development process (Comprehensive Plan Policy 4.8.4).

5.4.5.7 New Policies

FP-1 The City shall acknowledge and accommodate natural flooding within the floodplain, and avoid or minimize urban-created flooding patterns.

FP-2 Development of new buildings on undeveloped lands (where such development does not fall within the definition of infill contained in Article 50 of the Corvallis Comprehensive Plan) shall be prohibited in the 100-year floodplain of Corvallis streams, with the exception of the Willamette River, the Marys River, and the Mill Race. If pre-existing parcels are entirely within the 100-year floodplain or if this policy renders an otherwise buildable parcel unbuildable, exceptions may be considered to allow limited development.

FP-3 Streets, alleys, driveways, and parking lots on undeveloped lands, with the exception of the Willamette River, the Marys River, and the Mill Race, should be located outside the 100-year floodplain and wetlands unless it can be demonstrated that they are constructed in a manner that does not restrict or otherwise alter proper floodplain functions, will cause no harm to the properly functioning condition of the stream, and that no other reasonable option is available.

FP-4 Infill and redevelopment in the 100-year floodplain of Corvallis streams, with the exception of the Willamette River, the Marys River, and the Mill Race, shall maintain or improve stormwater functions and floodplain functions existing prior to the proposed infill or redevelopment, using techniques such as flow-through designs, more pervious surface area, and reduced building footprints. Development standards shall be created to allow additions to existing structures consistent with those structures' design, provided the additions fall below the threshold of "substantial improvement" contained in the Land Development Code and are constructed consistent with FEMA standards.

FP-5 Area-specific development standards for the 100-year floodplain of the Marys River, the Willamette River, and the Mill Race shall be instituted to maintain stormwater functions, be proportional to the impact of the development on the receiving water bodies, and minimize impacts to other properties.

FP-6 The City shall develop a program to acquire land and easements that become available over time within the 100-year floodplain that are cost effective and provide opportunities that best remediate existing, or prevent future, flooding loss or damage.

FP-7 The City shall work to protect hydrological processes associated with the 100-year floodplain to support self-sustaining levels of native fish, aquatic species, and wildlife populations.

FP-8 New City infrastructure, including streets and sanitary sewers, should be located outside the 100-year floodplain and wetlands unless it can be demonstrated that they will cause no harm to the properly functioning condition of the stream and that no other reasonable option is available.

FP-9 The City shall develop and implement incentives for floodplain protection, enhancement, and restoration as part of the development process.

FP-10 The City shall allow for a variety of low-impact uses on publicly and privately owned floodplain lands provided it can be demonstrated that they do not harm floodplain functions.

FP-11 The City shall work to accommodate housing and other development opportunities that are displaced by floodplain protection measures to ensure a compact development pattern.

5.4.5.8 Suggested Follow-Up Actions

1. The City shall investigate the feasibility of constructing bridges to span the 100-year floodplain or a portion of the 100-year floodplain of permanent stream corridors or otherwise maintain connections in the floodplain (such as multiple culverts). The investigation should consider different stream-crossing standards for stream floodplains and the Willamette and Marys Rivers' floodplain and backwater areas.

5.4.6 Stream System Management

5.4.6.1 Background

Stream systems in the Corvallis area include intermittent streams and stream reaches, perennial streams, and major rivers. Some of these streams and their watersheds are entirely within the Urban Growth Boundary (UGB), while others extend beyond the UGB into agricultural and forest resource lands.

For the purposes of the SWMP, a stream system is defined to include the channel, banks, and a corridor of land along the channel. However, this SWMP recognizes that a more complete description of a stream system would also include headwater swales, the floodplain, and streamside wetlands. Swales, floodplains, and wetlands were primarily addressed in the earlier sections of this chapter.

A stream's form and behavior can vary significantly from reach to reach and between different systems. These different forms can require different management strategies. The following list gives some examples, illustrating the variety of stream forms in the Corvallis stormwater management area:

- Stream confluences into the Marys and Willamette Rivers, with associated low gradients, and floodplain backwaters.
- Narrow, channelized, and sometimes incised stream reaches with development near or at the top of the bank. This development is often placed on fill in the floodplain.
- Widely meandering streams with a primarily native vegetative canopy and understory.
- Ditched stream reaches through agricultural lands, with a narrow, immature vegetative canopy. These ditches are sometimes modified natural swales and wetland corridors.
- Heavily wooded stream corridors with forested watershed.
- Narrow, low-flow and intermittent streams that are landscaped, mowed, and used by property owners.

Management of stream systems for stormwater includes proper design of stream corridor infrastructure such as bridges, ongoing best management practices, and the designation of appropriate stream corridors. The stream corridors provide for stormwater functions that do not degrade or conflict with other ecological functions.

The City provides stream system management to reduce the flood potential resulting from blockages, to control erosion from urban runoff, to lower stream water temperature, and to improve water quality and habitat through vegetation management. Future management can also provide stormwater benefits including improvement and protection of water quality, allowance for natural channel movement and bank erosion, accommodation for natural flooding and protection of floodplains, protection of adjacent wetlands, protection of biological resources, reduction of drainageway maintenance costs, and minimization of conflicts with abutting land uses.

The City's Land Development Code requires a drainageway dedication or easement along stream corridors at the time of development. The dedication or easement is of variable width based on one of two formulas and determined by several factors:

- Channel width;
- Presence of streamside vegetation;
- Additional width if channel is incised; and
- Includes the entire 0.2-foot floodway, or the floodplain up to 50 feet, whichever is greater.

5.4.6.2 Issues

Stream system management has changed significantly in the last 40 years. Previous stream management efforts focused on quickly draining urban areas and maximizing available land for development. As a result, stream sections in older areas of Corvallis were altered (narrowed, straightened, and developed close to the top of the bank with little or no vegetative canopy). In many cases the floodplain and streamside wetlands were filled. Groundwater supplies that feed streams are gone or no longer reach the stream channel, while small feeder streams were piped. This type of stream channel and corridor does not allow for proper stormwater functions or support additional stream functions such as maintaining water quality, moderating flow peaks, and protecting fish and wildlife habitat.

Typically, the health of a stream system is inversely related to the degree of urbanization. To discourage this historical trend from continuing, special measures are required to protect the health and vitality of the streams. The regulations relating to stream system management are addressed through several state and federal programs, including the flood insurance program, Endangered Species Act, and the Clean Water Act. For more details about these regulations, see Chapter 3.

Additional issues were identified during the SWMP process, which include:

1. The historical use of stream corridors for above- and below-ground utilities paralleling the stream created conflicts with proper stream functions (sewer lines were most common);
2. The need to maintain the historical connectivity between streams and groundwater, and the supplies of groundwater to feed streams;

3. Possible use of an outer zone along stream corridors for enhanced stormwater functions, such as bioswales;
4. Concern over recent proposals to build instream structures for in-channel detention and past problems associated with existing structures;
5. Ownership of stream corridors (public versus private);
6. Allowing streams and stream corridors to provide for stormwater functions without degrading these systems;
7. Replacement of native or other suitable plants with grass up to the stream bank, and placement of outbuildings within dedicated drainageway corridors;
8. With objectives such as stream system enhancement and restoration, both short-term and long-term approaches will be needed to achieve goals. Protection is often less costly than restoration; and
9. Contamination of waterways (e.g., animal waste, trash) resulting from trails along stream corridors and disrupted natural drainage patterns from impervious surfaces.

5.4.6.3 Citizen Input

Public input into stream system management was provided through a random telephone survey, interviews, and public meetings held by the SWPC. (See Appendix A for detailed survey and public meeting results.) Almost half of the 366 residents surveyed live within six blocks of a stream. These residents expressed strong support for protection of stream habitat, with 94 percent stating that this is an "important" or "very important" value. Likewise, they indicated that loss of stream habitat is an important issue.

The results of the stakeholder interviews indicate strong support for stream system management. Included as an important value was public access to streams. Citizens expressed a preference for solutions that provide multiple benefits, such as improving habitat and providing recreational opportunities.

In the public workshops, the SWPC provided the following range of alternatives for setting stream corridor widths:

- Maintain existing standards of 7 feet to 77 feet on each side of the channel, depending on stream channel width (or floodway width, or riparian vegetation width, whichever is greatest).

- Vary stream corridor widths to address stream corridor functions, with a minimum 50-foot width on each side of the stream, and a maximum width of 100 feet on each side of the channel, (or floodway width, or riparian vegetation width, whichever is greatest).

- Vary stream corridor widths to address stream corridor functions, with a minimum 50-foot width on each side of the stream, and a maximum width of 150 feet on each side of the channel, (or floodway width, or riparian vegetation width, whichever is greatest).

- Vary stream corridor widths to address stream corridor functions, with a minimum 50-foot width on each side of the stream, and a maximum width of 200 feet on each side of the channel, (or floodway width, or riparian vegetation width, whichever is greatest).

- Set stream corridor width based on location along the length, with each stream divided into three segments: upstream, midstream, and lower.

The majority of the attendees (62.5 percent) were opposed to the existing stream corridor widths. Of the 24 attendees, 63 percent supported a variable stream corridor width on each side of the channel of up to 200 feet.

5.4.6.4 Strategies to Address Issues

Stream system management will require a comprehensive strategy that acknowledges the existing and future urban development patterns and the need for stormwater infrastructure, yet provides support for protection and restoration of the natural functions of streams and riparian areas. A unified approach that balances the conflicting objectives will best meet the community needs and regulatory issues.

A key element of stream system management is establishing appropriate land uses within the stream corridor. City programs and policies for stream corridor management are encouraged to protect and restore stormwater functions without degrading or conflicting with other stream functions. Many of the policy recommendations in this section provide new stream system features that are directly related to the width of the stream corridor.

The stream corridor width required to adequately protect or restore a properly functioning stream will require follow-up study and planning activities. It is anticipated that the City will develop a new stream corridor width formula and definition that will address several objectives:

- Stormwater management;
- Endangered Species Act; and
- Significant Natural Features under Goal 5, of the Oregon Statewide Planning Goals

In response to the desires of the community, and as required by State and federal regulations, the SWMP provides programs and policy recommendations to protect and improve stream system management. In addition, recommendations are identified for activities that require further follow-up actions before implementation.

5.4.6.5 Goals

1. Map and inventory all streams.
2. Maintain and accommodate natural hydrological processes.
3. Protect and restore natural resources and ecosystem functions.

5.4.6.6 Existing Policies

1. Significant watercourses, lakes, and wetlands shall be preserved, or have their losses mitigated, in order to maintain clean water, support natural vegetation, protect the aquatic habitat, retain existing significant public vistas, and provide wildlife habitat and recreation sites. Site-specific

buffering and setback requirements may be required, as necessary, to achieve protection (Comprehensive Plan Policy 4.9.1).

2. Within the UGB, drainageway dedications adequate for flood protection, conveyance of stormwater, channel access and maintenance protection of riparian environment, and channel migration shall be secured along all open drainageways needed for public conveyance of stormwater, prior to or at the time of development. In already developed areas where dedications may not be possible, an easement may be pursued in lieu of a dedication (Comprehensive Plan Policy 4.10.4).
3. Significant natural plant communities and significant habitats for fish and wildlife within the UGB shall be identified and inventoried by the City or through the development process (Comprehensive Plan Policy 4.13.1).

5.4.6.7 New Policies

SS-1 The City shall inventory and identify natural intermittent streams within the City's Urban Growth Boundary (UGB) that provide important hydrological, water quality, and aquatic habitat functions. Those streams used for stormwater functions shall be protected using mechanisms such as drainageway dedications and easements.

SS-2 The City shall employ urban stormwater management practices that use a stream's natural features and processes and minimize conflicts with or degradation of the stream system's other ecological functions.

SS-3 On public projects, the City shall incorporate stream habitat improvement and shading.

SS-4 The City shall inventory all its land, including dedicated stream corridors, parks, and open space, to prioritize opportunities for stream and riparian habitat improvement.

SS-5 The City shall develop stream corridor widths and other standards and programs that preserve the properly functioning conditions of streams. These standards can vary by reach or basin and shall be determined based on functional objectives such as:

a. Preservation of the hydrologic conveyance and storage capacity.
b. Allowance for natural channel lateral migration and bank failure.
c. Allowance for channel widening and other channel modifications that result from changes in hydrology from future urban development.
d. Proper shading of the stream to maintain or improve water quality.
e. Allowance for a vegetative management strategy that encourages native riparian species.
f. Provision of a pollutant-filtering zone for surface runoff.
g. Allowance for natural stream processes to minimize stream channel, bank, and corridor maintenance needs.
h. Buffering of urban uses from stream processes.
i. Provision of a source and delivery of large wood.
j. Preservation of the 0.2-foot floodway.
k. Preservation or enhancement of habitat.

SS-6 The City shall develop standards and allowable uses within stream corridors. Consideration should be given to at least two levels of protection. Greater protection is necessary in the core-protected area to ensure that stormwater and other riparian and stream system functions and processes can occur. Protection is also necessary in the transition area, although there is a greater opportunity for other uses such as bikeways, detention facilities, and bioswales, as long as they do not significantly interfere with the stormwater functions outlined in SS-5 above. The transition area would also serve as a stream system buffer from more intensive urban development.

SS-7 Where stream shading is not adequate, development shall include planting of trees and/or other vegetation to provide adequate shading.

SS-8 The City shall work to enhance or restore degraded channels, riparian areas, and floodplains.

SS-9 The City shall inventory and prioritize possible replacement of culverts with bridges to improve stream function and fish passage.

SS-10 The City shall work to protect and restore native riparian vegetation along drainageways.

SS-11 The City shall minimize stream crossings of roads, utilities, and other development activities.

SS-12 Public access shall be allowed along stream corridors only if it does not impact the properly functioning condition of the streams.

SS-13 The City shall develop a program that encourages individuals, neighborhoods, and organizations to participate in stream corridor stewardship.

SS-14 The City shall work to develop maintenance practices that enhance and protect stream conditions.

SS-15 To provide improved shading and other stream functions, the City shall work to obtain additional easements or dedications as development occurs along streams.

SS-16 The City shall continue to develop policies to protect wetlands adjacent to stream corridors.

5.4.6.8 Suggested Follow-Up Actions

1. The City shall investigate ways to restore natural stream habitat functions and mitigate high stream temperatures.
2. The City shall investigate ways to protect existing stream systems, including channels, riparian areas, and floodplains for both permanent and intermittent streams.
3. The City shall identify intermittent streams within the UGB that provide important environmental functions.
4. As part of the current Land Development Code update, the City shall revise stream-width dedication formula to meet identified stormwater management needs.

5.4.7 Public Participation and Information Outreach

5.4.7.1 Background

The City encourages community participation in the management of local streams and natural resources. The City also provides stormwater management information and outreach related to household waste management, flood mitigation, and stormwater quality. Information outreach activities should communicate the goals and needs of the community's stormwater management program. In addition, public participation should be sought for a variety of activities, including stream stewardship programs and stream buffer planting events.

5.4.7.2 Issues

Many citizens are interested in learning how they can participate in programs that will protect, enhance, and restore the natural environment. To address this need, public education should be incorporated into the City's information outreach program. The education program should educate and inform the public on the importance of proper stormwater management techniques.

Stewardship programs for streams, wetlands, and other significant natural areas would allow community members to participate in and complement City activities. In addition, there are many types of demonstration projects that could be completed by the public or with public cooperation. These projects include stream restoration and protection, and can often be done with minimal cost, providing measurable benefit to the stream systems.

5.4.7.3 Citizen Input

Public input into the policy development task was provided through public meetings held by the SWPC. (See Appendix A for detailed public meeting results.) Public meetings showed citizen preference for a combined City staff and community volunteer approach to accomplish information outreach programs. Citizens also expressed a preference for outreach programs that target individual personal responsibility for control of stormwater pollution sources. Based on public input and regulatory requirements, the SWPC and the City developed policy objectives to provide a framework for creating the new policies.

5.4.7.4 Strategies to Address Issues

Most education programs that have proven effective in other Pacific Northwest communities are focused on improving and protecting water quality and the natural habitat of the streams. These efforts can include catch basin castings and stenciling, information on waste or materials management techniques, and general information on the importance of stormwater management. Other efforts such as flyers, newsletters, adopt-a-stream and stream-watch programs, educational signage, recognition and awards, and incentives help to educate and inform citizens about stormwater issues. Programs prepared for the grade schools and middle schools have proven effective. Citizen participation in stormwater issues can be facilitated through neighborhood associations, non-profit organizations, and community organizations.

5.4.7.5 New Policies

PP-1 The City shall establish information outreach programs that clarify personal responsibility for controlling sources of stormwater pollution and the health of streams.

PP-2 The City shall assume a proactive role by providing stream stewardship guidelines for streamside property owners.

PP-3 The City shall develop and support stewardship programs such as "Adopt-a-Stream" and neighborhood association "Stream Watch" to monitor and enhance stream and riparian habitat.

5.5 PROCESS FOR IMPLEMENTING POLICY RECOMMENDATIONS

This chapter of the SWMP discusses new policy recommendations that will be implemented following SWMP adoption. There are also recommendations for additional modifications to other City planning documents. Many of the recommendations will affect a number of City departments and may have economic, social, legal, and environmental impacts on the community. As a result, these additional modifications should be adopted only after careful consideration of all the impacts and after the recommendations are thoroughly reviewed by the public and the City. It is hoped that either all or a portion of this document will be adopted by Benton County, given that the same stormwater flows through both jurisdictions.

5.5.1 Programs and Procedures

Following City Council adoption of the SWMP, the City will determine how and when to implement the policies and recommendations. The City will consider the following forums for implementing the policy recommendations:

1. Budget Commission
2. Land Development Code
3. Capital Improvement Program
4. System development charges
5. Utility rate setting

Before any of the policies are implemented, they will be evaluated and forwarded to the appropriate forum for consideration. All of the forums noted above allow public input and require public hearings before final decisions are made.

5.5.2 Financing

The implementation of new stormwater management policies identified in this chapter will carry financial implications. There are currently short- and long-term costs to the City and others involved in managing current stormwater practices. The City will assess the cost and timing of implementing policy recommendations through the Capital Improvement Program, the budget process, system development charges, and rate setting. City financial resources and a schedule for implementation should be identified to appropriately fund what the City determines to be a priority.

Many of the policy recommendations included in the SWMP will require significant changes to existing City services and programs. The costs associated with the increased level of services will need to be evaluated and prioritized before implementation.

5.5.3 Early Action Items

Many of the policy recommendations in this chapter target existing regulatory issues that require short-term actions and changes to City programs. It should be noted that the City is currently conducting a Natural Resources Scoping Project to determine which natural resources in the community should be protected and preserved. In addition, regulatory implications resulting from the Endangered Species Act are also being evaluated to determine actions that may be necessary to preserve threatened and endangered species, and their habitats. Both of these efforts could result in actions that affect stormwater policies.

Implementation of policy recommendations that relate to floodplains, uplands natural resources, wetlands, and stream system management will require background work to identify certain parameters before being fully implemented. The floodplain management policies will require that the 100-year floodplain boundaries be updated for each basin within the City's UGB. The upland natural resources, wetlands, and stream system management policies will require resource inventories. This work is currently programmed under Statewide Planning Goal 5 and related natural resource inventory work. The early action and identification of the significant natural resources should be prioritized in the natural resources inventory process.

The upland natural resources, wetlands, and stream system management policies will also require a method of assessing the properly functioning conditions of the resources within each area to meet stormwater objectives. The City will need to identify a method to evaluate the properly functioning conditions and the protection, restoration, and enhancement requirements to meet policy recommendations. Identifying the methodology for properly functioning conditions and conducting a natural resource evaluation will be an extensive work effort that will require early action to fully implement related policies.

To effectively implement the policies, it will be important for the City and County to work together on stormwater issues. Developing an agreement between the City and the County will be an important step in properly managing the watersheds.

5.5.4 Protection and Restoration Programs

Many of the policy recommendations included in this chapter require protection and restoration of natural resources within the City's UGB. Implementation of policies may require changes to current land management practices, both for public and privately owned lands. A process of evaluating current land use and management practices to identify the changes required to best implement the policy recommendations is recommended. In some cases, a required change to land use will require public purchase of properties. A program of incentives for private property owners to manage properties to meet stormwater management goals should also be developed. In addition, open-space land use guidelines should be evaluated for opportunities to implement restoration and protection policies.

5.5.5 Policy Implementation Within Each Basin

The recommendations for each basin within the City's UGB include implementation of policy recommendations. Water quality features, restoration, protection activities, and mitigation of flood effects were identified for each basin in an effort to support policy recommendations.

5.5.6 City Appointed Stormwater Planning Commission

The Stormwater Planning Committee recommends the City consider appointing a Stormwater Planning Commission. This group could help track implementation of the recommended policies and facilitate citizen input on issues that are of significant concern to the community.

CHAPTER 6

WATERSHED PLANNING AND ANALYSIS: DIXON CREEK

6.1 INTRODUCTION

Dixon Creek originates in the hills to the northwest of Corvallis. Most of its length lies within the City where it is an important feature of many residential backyards. It also runs through several school properties and parks before reaching commercial property at 9th Street and Reiman Avenue and, shortly thereafter, the Willamette River. The Dixon Creek watershed contains 2,712 acres. The largest land use at present is low-density residential, which covers over one third of the watershed. In addition, medium-density residential, Oregon State University forest (McDonald Forest) land, and vacant parcels each cover about 400 acres.

In the future, if the watershed is developed to full build-out according to the City's Comprehensive Plan, the current vacant land may be largely converted into low- and high-density residential use. Other changes may include a decrease in medium-density residential and an increase in commercial land use. Overall, the number of impervious acres is estimated to increase by 13 percent, from 897 acres to 1,017 acres.

6.2 WATERSHED FINDINGS

Information on watershed conditions was obtained by collecting public comments at open houses, working with City staff to identify maintenance and operation problems, conducting a technical stream evaluation of selected reaches, and modeling the conveyance system for the existing and future build-out scenarios. This information was compiled by stream reach and is summarized in Section 6.2.5. A map of the Dixon Creek watershed, presented as Figure 6-1, shows the location of the stream within the City and identifies some of the major observations made during the watershed study.

Dixon Creek has the characteristics of a highly urbanized stream: increased channel widths and depths with accelerated bank erosion. In most places, the channel is tightly constrained between encroaching houses or other buildings, often a result of filling or stream channel realignment, as shown in Figure 6-2, Photo 1. The encroachment has contributed to flooding and erosion problems, and to habitat loss.

The City has completed several projects in recent years designed to improve conditions in Dixon Creek. Channel restoration and habitat improvements have taken place at Porter Park and at Jefferson School, as shown in Figure 6-2, Photos 2 and 3, respectively. The increased culvert capacity that was provided at Grant Avenue and Garfield Avenue in 1997 has lessened flooding problems along the creek, as shown in Figure 6-2, Photo 4.

Many opportunities for improvements exist in the Dixon Creek watershed. Figure 6-2, Photo 5 shows an example of commercial parking lots along the lower reaches of Dixon Creek draining directly to the creek without water quality treatment. All reaches of the stream offer riparian enhancement opportunities, as shown in Figure 6-2, Photo 6. Some of these opportunities will be lost if not implemented prior to further development.

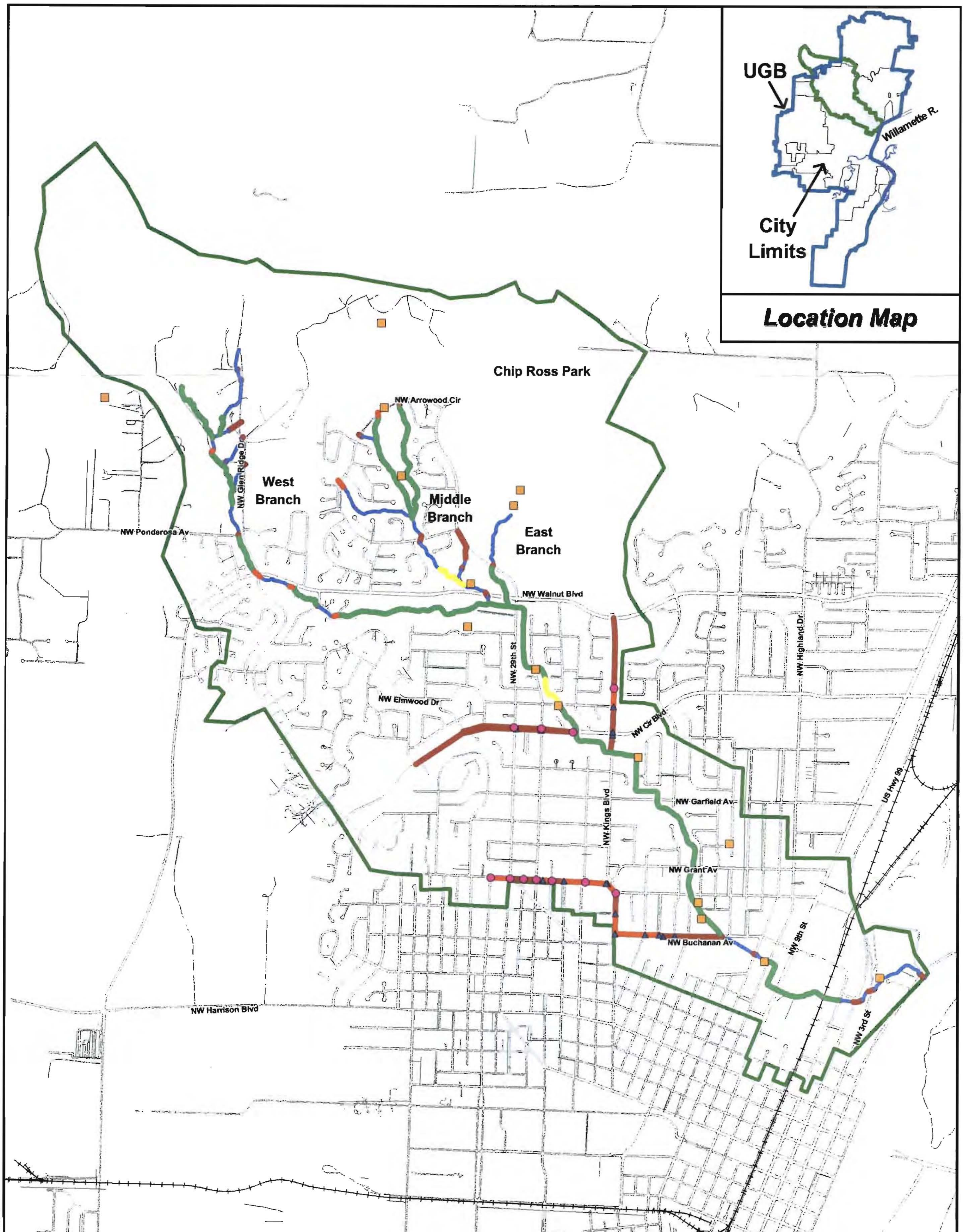


Figure 6-1 Dixon Creek Problem Areas

LEGEND

Pipes/Bridges
Channels
Basin Boundary
Reported Problems (recorded at open house)
Surcharged Manholes (10-year future storm)
Flooded Manholes (10-year future storm)
High Velocity Areas (> 4 fps, 2-year future storm)
Undersized Conduits (10-year future storm)
Undersized Channels (10-year future storm)

N

Feet 600 0 600 1200 1800 2400 Feet

CORVALLIS
ENHANCING COMMUNITY LIVABILITY
Public Works Department

BROWN AND CALDWELL
and Associated Firms

report/figures/Fig6-1v4.wor, October 12, 2000, base data from City of Corvallis GIS Department

Figure 6-2. Watershed Photos

Photo 1. Constricted Dixon Creek channel

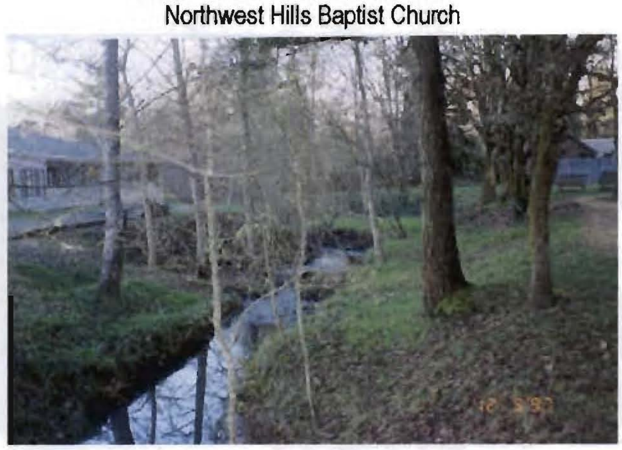
Photo 2. Channel restoration at Porter Park

Photo 3. Riparian improvements at Jefferson School

Photo 4. New culverts at Garfield Avenue

Photo 5. Parking lot runoff at Avery Square Shopping Center

Photo 6. Enhancement opportunities behind Northwest Hills Baptist Church



6.2.1 Public Comments

The Stormwater Planning Committee (SWPC), with the support of City staff, has encouraged and facilitated public input into the watershed planning process. Public meetings were held at the Northwest Hills Baptist Church located within the watershed. The first meeting was held on March 30, 1999, and the second on April 6, 1999. During the meetings, residents were encouraged to share their knowledge of problem areas and to identify opportunities for improving the health of Dixon Creek, its watershed, and its stormwater functions. Reach-specific comments are in Section 6.2.5. Some general comments are provided below:

- "Should protect natural areas (including wetlands). Natural areas promote wildlife."
- "Lower part of Dixon Creek is choked with algae during summer."
- "People do things to channels without understanding impacts."
- "On Dixon Creek, erosion occurs where there is inadequate vegetation."
- "Increased flooding from upslope development."

6.2.2 City Staff Reports

City Engineering and Utilities Operation staff is very familiar with most of the watershed through their day-to-day activities. They provided input into the planning process by identifying known problem areas, recommending areas for stream enhancement activities, and recounting the extent and duration of flooding during major storm events. For example, the extent of flooding from the February 1996 storm was well documented. During that storm, high water and road closures were common within the region bound to the west by Kings Boulevard, to the north by Circle Boulevard, to the east by 9th Street, and to the south by Buchanan Avenue. To reduce the potential for future flooding, especially in the Arthur Circle area, the City initiated a flood mitigation project that added culvert capacity at Grant Avenue and Garfield Avenue, and increased channel capacity by laying back the stream banks at Porter Park. As a result, the conveyance system has undergone less flooding in these reaches during subsequent large rainfall events, including the December 28, 1998 storm, which was a 10-year event.

6.2.3 Field Study Observations

Watershed Applications, a stream rehabilitation specialty firm, conducted a series of field investigations beginning in November 1997 to provide input on the health of City streams. Field personnel evaluated selected lengths of Dixon, Squaw, Sequoia, Jackson, Frazier, and Oak Creeks during these stream walks. A summary of their observations is in section 6.2.5. Detailed descriptions of the field study observations are in Appendix B.

6.2.4 Modeling Results

A computer model for the Dixon Creek watershed identified the hydraulic capacity and projected flows in the pipes, culverts, and channels of the conveyance system for existing and future build-out scenarios. Existing conditions are based on the current level of development at the time of modeling. See Chapter 3 for modeling parameters and assumptions. Future conditions are based on full development (build-out) of the watershed as identified in the City's Comprehensive Plan. A full range of storm events was modeled for the existing and future scenarios, including the 2-, 10-, 25-, and 100-year storm events.

Table 6-1 shows the hydraulic structures (pipes, culverts, bridge crossings, etc.) that are undersized for the City's 10-year design storm. It is important to note that flooding reported by staff and the public was likely more than in a 10-year storm event. Undersized structures are defined as being surcharged (under pressure) or experiencing flooding. Recommendations to address the undersized structures are in section 6.3. A complete summary of all modeled segments is in Appendix C.

Flooding of the Willamette River impacts the capacity of Dixon Creek's downstream reaches. For example, the Willamette River 100-year floodwater elevation covers the area up to an elevation of 218 feet; consequently, the capacity of the channel immediately upstream of elevation 218 is reduced. The model was constructed to determine the capacity of the channel without the backwater effects of the Willamette River. The modeling shows two channel sections where water elevations from the design storm will overtop the streambank. Both segments occur where surveyed cross-section information was not available; therefore, the channel cross-sections were estimated.

Table 6-1. Modeled Flow for Undersized Hydraulic Structures within the Dixon Creek Watershed, cubic feet per second

Reach/Location/Model segment	Full pipe or channel capacity	10-year storm flows		Flooding predicted by model	Flooding reported by staff or public
		Existing	Future		
9th Street to Buchanan Avenue/Undersized pipe along Buchanan Avenue from 18th Street to 19th Street /DIX275	29	31	31	No	Yes
9th Street to Buchanan Avenue/Undersized pipe along Buchanan Avenue from 19th Street to Kings Boulevard /DIX280	30	31	31	No	Yes
9th Street to Buchanan Avenue/Undersized pipe along Kings Boulevard from Buchanan Avenue to Lincoln Avenue /DIX285	30	31	31	No	Yes
9th Street to Buchanan Avenue/Undersized pipe along Kings Boulevard from Beca Avenue to Grant Avenue /DIX295	12	13	13	Yes	Yes
9th Street to Buchanan Avenue/Undersized pipe along Grant Avenue from Kings Boulevard to 23rd Street. Flooded manhole /DIX300, DIX305	11	13	13	Yes	No
9th Street to Buchanan Avenue/Undersized pipe along Grant Avenue from 26th Street to 27th Street. Flooded manhole /DIX320, DIX325	7.4	8.3	8.3	Yes	No
9th Street to Buchanan Avenue/Undersized pipe along Grant Avenue from 29th Street to 30th Street. Flooded manhole /DIX340	14	15	15	Yes	No
Garfield Avenue to Kings Boulevard/Undersized pipe along Kings Boulevard from Elmwood Drive to Larch Avenue. Flooded manhole /DIX435	18	19	19	Yes	Yes

Reach/Location/Model segment	Full pipe or channel capacity	10-year storm flows		Flooding predicted by model	Flooding reported by staff or public
		Existing	Future		
Kings Boulevard to Circle Boulevard/Undersized pipe along Circle Boulevard discharging into Dixon Creek. Flooded or surcharged manholes along Circle Boulevard from Dixon Creek to 29th Street /DIX395	34	62	62	Yes	Yes
Circle Boulevard to 29th Street/Overflow in channel upstream of Elmwood Drive /DIX613	157	354	358	Yes	No
29th Street to Walnut Boulevard (West Branch)/Undersized culvert at Walnut Place /DIX830	62	90	92	Yes	No
29th Street to Walnut Boulevard (West Branch)/Undersized culvert at Witham Village /DIX850	132	100	100	Yes	No
Walnut Boulevard to Headwaters (West Branch)/Undersized culvert at Walnut Boulevard /DIX860	186	118	119	Yes	No
Walnut Boulevard to Headwaters (West Branch)/Undersized culvert at Live Oak Drive /DIX920	29	27	27	Yes	No
Walnut Boulevard to Headwaters (Middle Branch)/Overflow in channel upstream of pond along Walnut Boulevard /DIX698	65	91	93	Yes	No
Walnut Boulevard to Headwaters (Middle Branch)/Undersized culvert at Arrowood Circle near Sitka Place /DIX800	20	8.0	8.4	Yes	No
Walnut Boulevard to Headwaters (Middle Branch)/Undersized culvert at Arrowood Circle between Boxwood Place and Snowbrush Drive /DIX755	43	24	25	Yes	Yes
Walnut Boulevard to Headwaters (Middle Branch)/Undersized culvert at Arrowood Circle near Snowbrush Drive /DIX730	12	10.3	10.5	Yes	Yes

The hydrologic/hydraulic model also estimated velocities occurring in channel segments to determine areas at risk for channel or streambank erosion. The velocities during the 2-year storm—the storm size most responsible for determining the channel configuration—were compared to the velocity criteria presented in Chapter 3. In general, the criteria identify that velocities in excess of 4 feet per second may cause erosion of the streambank or streambed. Those segments with velocities in excess of the criteria are shown in Table 6-2. Recommendations to address the areas with high velocities are shown in Table 6-3.

Due to steep slopes and the confined nature of the channel, the model predicts that the majority of the Dixon Creek channel shows velocities above the criteria, resulting in erosion. Some of these areas have been identified as having erosion problems (Figure 6-2, Photo 6). However, property owners or the City have already stabilized some of the channel segments at risk of erosion (Figure 6-2, Photo 1).

Table 6-2. Modeled Velocities for Dixon Creek Channel Segments Exceeding 4 Feet per Second

Reach/Model segment	2-year storm		Erosion observed	Existing bank stabilization
	Existing velocities	Future velocities		
3rd Street to Railroad Tracks/DIX220	5.62	5.62	Yes	No
Railroad Tracks to 9th Street/DIX490	6.83	6.84	Yes	No
Railroad Tracks to 9th Street/DIX500	6.71	6.74	Yes	No
9th Street to Buchanan Avenue/DIX510	4.96	4.98	Yes	No
Buchanan Avenue to Grant Avenue/DIX540	5.65	5.68	Yes	No
Buchanan Avenue to Grant Avenue/DIX555	4.44	4.47	Yes	No
Grant Avenue to Garfield Avenue/DIX565	5.06	5.08	Yes	Yes
Grant Avenue to Garfield Avenue/DIX570	5.00	5.06	Yes	Yes
Garfield Avenue to Kings Boulevard/DIX580	6.05	6.11	Yes	No
Garfield Avenue to Kings Boulevard/DIX585	4.38	4.47	Yes	Yes
Kings Boulevard to Circle Boulevard/DIX595	8.20	8.21	Yes	Yes
Circle Boulevard to 29th Street/DIX605	4.21	4.22	No	No
Circle Boulevard to 29th Street/DIX613	5.78	5.84	No	Yes
Circle Boulevard to 29th Street/DIX615	4.83	4.87	No	Yes
Circle Boulevard to 29th Street/DIX625	6.10	6.14	Yes	Yes
Circle Boulevard to 29th Street/DIX630	4.22	4.25	Yes	Yes
29th Street to Walnut Boulevard (West Branch)/DIX665	6.76	6.77	Yes	No
29th Street to Walnut Boulevard (West Branch)/DIX805	5.53	5.55	No	No
29th Street to Walnut Boulevard (West Branch)/DIX810	5.19	5.20	Yes	No
29th Street to Walnut Boulevard (West Branch)/DIX815	5.51	5.52	Yes	No
29th Street to Walnut Boulevard (West Branch)/DIX820	5.31	5.33	Yes	No
29th Street to Walnut Boulevard (West Branch)/DIX825	6.23	6.24	No	No
29th Street to Walnut Boulevard (West Branch)/DIX845	4.81	4.82	Yes	No
Walnut Boulevard to Headwaters (West Branch)/DIX865	10.17	10.15	Yes	No
Walnut Boulevard to Headwaters (West Branch)/DIX885	7.87	7.89	Yes	No
Walnut Boulevard to Headwaters (West Branch)/DIX890	7.16	7.17	No	No
Walnut Boulevard to Headwaters (West Branch)/DIX915	8.34	8.34	No	No
Walnut Boulevard to Headwaters (West Branch)/DIX930	6.43	6.41	No	No
Walnut Boulevard to Headwaters (West Branch)/DIX950	4.13	4.13	No	No
Walnut Boulevard to Headwaters (Middle Branch)/DIX710	5.69	5.78	No	No
Walnut Boulevard to Headwaters (Middle Branch)/DIX715	5.70	5.78	No	No
Walnut Boulevard to Headwaters (Middle Branch)/DIX720	5.58	5.68	No	No
Walnut Boulevard to Headwaters (Middle Branch)/DIX725	4.36	4.45	No	No
Walnut Boulevard to Headwaters (Middle Branch)/DIX735	6.33	6.38	Yes	No
Walnut Boulevard to Headwaters (Middle Branch)/DIX740	5.56	5.62	Yes	No
Walnut Boulevard to Headwaters (Middle Branch)/DIX745	6.94	7.01	Yes	No
Walnut Boulevard to Headwaters (Middle Branch)/DIX750	4.23	4.28	No	No
Walnut Boulevard to Headwaters (Middle Branch)/DIX760	5.78	5.84	Yes	No
Walnut Boulevard to Headwaters (Middle Branch)/DIX795	3.88	4.08	No	No
29th Street to Headwaters (East Branch)/DIX640	4.62	4.62	Yes	No
29th Street to Headwaters (East Branch)/DIX650	4.38	4.40	Yes	No

Note: Only segments with velocities in excess of 4 feet per second were selected.

6.2.5 Stream Reach Summaries

For study purposes, Dixon Creek was divided into a number of reaches based on physical characteristics of the stream, property ownership, and any other unique characteristics that might distinguish one section of the stream from the rest. The study findings are summarized in the following sections by reach description. The comments provided by the public are shown as they were recorded during public meetings. Clarification of the comments is provided, where necessary, and is shown in parenthesis.

Willamette River to 3rd Street

Public Comments: "Severe erosion. High velocity after Highway 99. Lost two oak trees."

City Staff Reports: Woody debris can be found within several sections of the channel. The tree cover in this reach is good. During summer months a stagnant pool exists upstream of the culvert at 2nd Street. During low-flow periods, fish passage is not possible at the downstream end of the culvert on 2nd Street due to the current culvert configuration. A recent stream restoration project improved flow characteristics and replanted the streambanks near 3rd Street. Improvements included widening the south side of the bank to establish a low-flow channel and increase high-flow capacity. Private ownership extends to the centerline of the creek on the south side, and the City owns the north side.

Field Observations: A technical evaluation of the physical conditions within this reach was not performed.

Modeling Results: Culverts and bridges within this reach are adequately sized for the full range of modeled storms for existing and future build-out conditions. Stream velocities were predicted to be relatively low for the 2-year storm event. This area is in the Willamette River 100-year floodplain with floodwater elevations to an elevation of 218 feet. Water surface elevation in downstream portions of Dixon Creek will be impacted by Willamette River flood events.

3rd Street to Railroad Tracks

Public Comments: No public comments were received for this reach.

City Staff Reports: The channel is narrow and incised throughout this reach. A portion of this reach has been dedicated to the City. This reach lacks adequate tree canopy shading. No flooding was experienced in this area, even during the 1996 and 1998 storm events. Oregon Department of Transportation (ODOT) owns the area between 3rd and 4th Streets. Fish passage issues through culverts in this area will need to be addressed by ODOT. City Parks Department maintains the area through an intergovernmental agreement with ODOT.

Field Observations: A technical evaluation of the physical conditions within this reach was not performed. Prior to urbanization, this portion of Dixon Creek provided downstream storage capacity. When development occurred in this area, fill was imported to minimize seasonal flooding.

Modeling Results: Culverts and bridges within this reach are adequately sized for the 10-year storm event for existing and future build-out conditions. The model showed that stream velocities between 5th Street and the railroad tracks would exceed the 4-feet-per-second criteria during the 2-year storm event.

Railroad Tracks to 9th Street

Public Comments: "How much responsibility does Avery Square have for stream discharge?"

City Staff Reports: A Stream Restoration Project was recently completed on a small section of this reach. The channel and adjacent lands in this reach have been dedicated to the City. This reach lacks adequate tree canopy shading. The City has not received reports of flooding in this area even during the 1996 and 1998 storm events. The left bank (facing upstream) at Avery Square is experiencing erosion and bank failure.

Field Observations: Overhead canopy coverage is very poor, and overall instream and riparian habitat quality is extremely poor. Native herbaceous wetland species such as rushes and sedges (e.g. Scirpus sp.), along with reed canarygrass and other weedy graminoids, occur along the channel bottom upstream of Reiman Avenue. Stormwater runoff entering the stream directly from the Avery Square parking lot could contribute to water quality degradation. Slump failures of the over-steepened left bank (facing upstream) are located downstream of 9th Street. Significant erosion is evident on the right bank downstream of the Reiman Avenue crossing. Minor bank erosion from Reiman Avenue to 9th Street.

Modeling Results: Culverts and bridges within this reach will pass the 10-year storm event for existing and future build-out conditions. Stream velocities in this reach exceed the 4-feet-per-second criteria during the 2-year storm event.

9th Street to Buchanan Avenue

Public Comments: "House is 20 feet from creek and slowly settling. House is 40 years old. (Stream bank stability is suspect.)"

City Staff Reports: A City Stream Restoration Project was recently completed at Corvallis High School. A City sanitary sewer located downstream of 11th Street acts as a low dam that ponds water upstream of the pipe crossing. A 36-inch storm sewer enters the stream near the Buchanan Avenue bridge. The 36-inch sewer serves the drainage basin to the west, which is a mix of commercial and residential development. This storm drain presents an opportunity for end-of-pipe treatment prior to discharge to Dixon Creek. This reach has mixed tree cover. Private ownership extends to the centerline of the stream. Parking lots upstream of 9th Street drain directly to the creek. Sediment accumulations occur near the high school.

Field Observations: Significant bank erosion was observed at Corvallis High School, including a partially slumped area of the right bank about 200 feet downstream of Buchanan Avenue. Since the time of the field observation, the City has stabilized a section of this reach (as noted under City Staff Reports). Stormwater runoff from school property discharges directly to the stream with potential water quality degradation. Non-native English Laurel provides fair canopy cover within this reach.

Overall instream and riparian habitat quality is low. A 12-inch diameter (sanitary sewer) pipe and rubble cover forms a low weir with a 1.5-foot drop about 125 feet downstream of 11th Street. This blockage creates fish passage issues and may raise water temperatures. A revetment composed of demolition debris is located at the bend downstream of 10th Street. Fine-sized sediment deposits accumulate upstream of 9th Street due to the low stream gradient. The outside bend of the channel upstream of 9th Street is progressively failing along the steep banks.

Modeling Results: Modeling showed that existing culverts and bridges within this reach are adequately sized for the existing and future build-out conditions. Most of the pipe system that runs from Buchanan Avenue to Kings Boulevard to Grant Avenue is undersized during the 10-year storm event. Stream velocities between 9th and 10th Streets exceed the 4-feet-per-second criteria during the 2-year storm event.

Buchanan Avenue to Grant Avenue

Public Comments: "Wants engineer to visit. Experiencing erosion of bank."

"Erosion – undercutting of west bank between Beca Avenue and Buchanan Avenue."

City Staff Reports: This reach has excellent tree cover. Private property extends to the centerline of the stream. Some private property owners have constructed their own stream restoration project in this reach. Ponding of water occurs upstream of an instream concrete obstruction at 15th Street and Lincoln Avenue.

Field Observations: Overhead canopy cover in this reach is generally good with canopy provided largely by ornamental plants and conifers. Overall instream and riparian habitat quality is low. The left bank is eroding downstream of the junction of 15th Street and Lincoln Avenue and excessive sediment has accumulated upstream of the Buchanan Avenue culvert.

Modeling Results: Structures along this reach are adequately sized to pass the 10-year storm event. Modeled stream velocities in this reach for the 2-year storm event exceed the 4-feet-per-second criteria.

Grant Avenue to Garfield Avenue

Public Comments: "13th and Greeley - still localized flooding that goes up and down with stream. Can the City route storm drain to south (near high school)?"

City Staff Reports: Vista Place (near Grant Avenue and 15th Street) had high water in the street during the February 1996 storm. A City Flood Mitigation Project was completed at both the Grant Avenue and Garfield Avenue crossings by the construction of high-flow culverts, and by laying back and revegetating the streambanks. Property owners have provided the City with maintenance easements in this reach. The City will maintain the channel in this reach to help provide hydraulic capacity. Porter Park has problems with pet wastes and lack of tree canopy. The park is a candidate site for a water quality or flood storage facility.

Field Observations: Overhead canopy cover in this reach is generally good with canopy provided largely by ornamental plants and conifers. The streambank has been laid back and matting added prior to planting willows. Foot traffic is heavy through this reach with a well-worn trail along the south bank of the stream. Overall instream and riparian habitat quality is low.

Modeling Results: Existing culverts and bridges are adequately sized for the full range of modeled storms for existing and future build-out conditions. Stream velocities in this reach are above the 4 feet per second criteria for the 2-year storm event.

Garfield Avenue to Kings Boulevard

Public Comments: "Autnuk (Arthur) Circle - concern about the rapid rise in creek, even for smaller storm events."

City Staff Reports: The February 1996 storm caused high water and closed roads in several locations. Flooding was especially severe along Arthur Circle. A Flood Mitigation Project improved the hydraulic conditions in this area and no flooding problems have been noted since the project. Some flooding complaints during large storms have been received from residents along Kings Boulevard north of Dixon Creek. Maintenance easements have been acquired for stream access in this reach. The large storm drain coming into Dixon Creek at Kings Boulevard has the potential for end-of-pipe treatment technologies.

Field Observations: Overhead canopy cover in this reach is generally good with canopy provided largely by ornamental plants and conifers. Overall instream and riparian habitat quality is low. A major storm drain discharges into Dixon Creek within this reach at the culvert in Kings Boulevard. This line originates near Walnut Boulevard and runs parallel to Kings Boulevard.

Modeling Results: The culverts within this reach can pass the range of modeled storms for existing or future build-out conditions. A section of the piped system located along Kings Boulevard to the north between Elmwood Drive and Larch Avenue is undersized for the 10-year storm event. Stream velocities in this reach exceed the 4 feet per second criteria for the 2-year storm event.

Kings Boulevard to Circle Boulevard

Public Comments: No public comments were received for this reach.

City Staff Reports: A City Stream Restoration Demonstration Project was completed in this reach in 1997. The Jefferson School property has the potential to be used for flood storage or a water quality project. A major storm pipe running along Circle Boulevard discharges into Dixon Creek in this reach. Large storms cause manholes to flood along parts of Circle Boulevard, but the flows drain along the street until they reach the next inlet and re-enter the system. This piped system presents an opportunity for end-of-pipe treatment.

Field Observations: Sediment accumulation in a box culvert at Circle Boulevard has reduced the hydraulic capacity of this structure. Relatively recent enhancement plantings at the Jefferson School site have supplemented mature alders on the south bank. As a result, the canopy coverage of the channel should improve over time. Low-flood benches with undercut banks are extensive along this reach. Overall, the instream and riparian habitat conditions are degraded; however, recent riparian enhancements should improve conditions. A large open space area immediately adjacent to the stream provides a potentially valuable opportunity to create a relatively large passive flood storage facility. This site, part of the Jefferson School property, could be a true multi-objective urban stream rehabilitation project. Habitat, recreational, and visual improvements could be readily integrated into the flood alleviation design. A major storm drain discharges into Dixon Creek at the culvert in Circle Boulevard. The storm drain originates in Woodland Meadows and runs parallel to Circle Boulevard to its discharge point.

Modeling Results: The pipe discharging from Circle Boulevard to Dixon Creek is undersized for the 10-year storm event for both existing and future conditions. Several manholes are flooded or surcharged along Circle Boulevard. The open channel segment in this reach shows modeled velocities in excess of 4 feet per second for the 2-year storm event.

Circle Boulevard to 29th Street

Public Comments: "Blue heron, nutria, beaver, ducks, et al. used to be in this area. All gradually gone. Can we improve habitat for wildlife?"

City Staff Reports: This reach has some streambank erosion. Telephone poles are used in one segment of the stream to help protect the banks. Public education may help promote stream stewardship activities and to discourage activities with potential negative effects. The culvert at 27th Street limits fish passage. Private ownership extends to the center of the creek in many areas. The City has easements in other areas. Property owners have reinforced the bank with concrete slabs in many locations.

Field Observations: Closely spaced alders form a significant channel pinch point at 29th Street. Fish passage is hampered at the box culverts beneath 27th Street. Grass-covered flood benches occur, some forming significant undercut banks. Overhead canopy cover is moderately good considering small channel size. Bare upper bank areas occur between 27th and 29th Streets, which are subject to low levels of erosion. Overall instream and riparian habitat quality is low, in part due to the armoring of streambanks along this reach.

Modeling Results: The model shows that the channel upstream of Elmwood is undersized and that flow overtops the banks for the 10-year storm event. The channel and bank geometry in this area should be confirmed with a topographic survey. Stream velocities exceed the 4-feet-per-second criteria for the 2-year storm event along this entire reach.

29th Street to Walnut Boulevard (West Branch)

Public Comments: "Drainage from Roosevelt to Taft - flooding houses and basements."

"Oak Creek drainage (Skyline West) going into Dixon Basin? Could this be re-routed to Oak?"

City Staff Reports: This reach has some good stream functions. Blackberry is common along stream banks in this reach. The City has maintenance easements along most of this reach of the stream. The large parking lot at the Northwest Hills Baptist Church may be contributing to water quality degradation. Water elevations have been high in this reach, but no reports of flooding. Public education and institutional cooperation could present stream stewardship opportunities along this reach.

Field Observations: A large area (+5 acres) of open space in the vicinity of the Northwest Hills Baptist Church, which is most likely used for seasonal recreation, presents an opportunity for significant flood storage. A passive flood storage facility could be designed to enhance natural features and offer recreational use of the area during the non-flood season. Bank and channel erosion was observed at locations along Walnut Boulevard, upstream of 29th Street behind Hoover School and the Northwest Hills Baptist Church.

Modeling Results: Culverts at Walnut Place and Witham Village appeared undersized for the 10-year storm event. Velocities in excess of 4 feet per second were modeled in several segments of this reach for the future 2-year storm event.

Walnut Boulevard to Headwaters (West Branch)

Public Comments: No public comments were received for this reach.

City Staff Reports: This reach has good canopy cover and fish habitat. A portion of the drainage system originates in the County. One of the side branches drains into a field inlet above Amanda Place. At this location, improvements to the channel and field inlet were made as part of the City's 1999 Flood Mitigation Project. A section of the streambank along Glenridge Drive has overly steep banks covered with blackberries. An experimental fish passage culvert has been installed at Acacia Place.

Field Observations: A technical evaluation of the physical conditions within this reach was not performed.

Modeling Results: The models shows that the culverts under Walnut Boulevard and Live Oak Drive are undersized for the 10-year storm event under existing and future build-out conditions. Stream velocities in this reach exceed the 4 feet per second, 2-year storm criteria in several places.

Walnut Boulevard to Headwaters near Arrowood Circle (Middle Branch)

Public Comments: "Forested slope vs. grassed in other areas difference between the two in planning."

"Near Arrowood – drainage on street not properly placed and flows from West Fork west to other tributary."

"Summer flow is polluting the Timberhill Dixon tributaries. Also, North Fork channel was filled with sediment. North Fork used to be main channel; now channel to the west is the larger channel. Also, upslope of Arrowood, land is now cut off from downslope, which alters seepage."

"Old detention facility silted in."

City Staff Reports: Residential yard encroachments into the riparian areas have occurred.

Field Observations: This area has the potential to be a valuable demonstration project located in a highly visible area. The project could demonstrate low-tech and aesthetically pleasing strategies for relieving chronic sedimentation/erosion from small headwater streams with poor instream and riparian habitat conditions, such as the 300-foot-long segment immediately above Arrowood Circle. Walnut Boulevard culverts have fish passage issues and excess sediment accumulation. There is potential water quality degradation at 29th Street and Timberhill Park resulting from domestic animal waste. Channel erosion was noted for 300 feet upstream of Arrowood Circle near Sitka Place. The creek is mostly designated as open space in this reach and access is good.

Modeling Results: Model results show that the channel upstream of the pond is undersized, although this needs to be confirmed with additional surveys of channel cross-sections. Three of the four culverts under Arrowood Circle are undersized for the 10-year storm event, although the amount of flooding appears to be less than 1 cfs except near Snowbrush Place. The two branches of the channel in the greenway between Twinberry Place and Huckleberry Place both appear to have velocities that exceed the 4-feet-per-second criteria for the 2-year storm event.

29th Street to Headwaters in Chip Ross Park (East Branch)

Public Comments: "Springs all over hillsides."

"Natural springs are impacted by development."

"Timberhill area yet to be developed, wants to have quality protection of ecological functions and values."

"Timberhill runoff is causing problems in the existing development."

City Staff Reports: This area is in relatively good shape and has the opportunity to be preserved. The culvert in 29th Street may impact fish passage.

Field Observations: A technical evaluation of the physical conditions within this reach was not performed.

Modeling Results: Full stream bank capacity was not exceeded by the range of modeled storms for existing or future build-out conditions. Stream velocities near Walnut Boulevard exceed the 4 feet per second, 2-year storm event criteria in Timberhill Park.

6.2.6 Watershed Summary

Most of the Dixon Creek channel has flow velocities that exceed the erosion criteria of 4 feet per second during the 2-year storm event. To prevent erosion, residents have armored the streambanks along many of these segments. Most of the culverts and bridges along Dixon Creek are large enough to pass the 10-year storm event, in part due to several City projects constructed within the last few years. However, several pipe systems contributing to Dixon's middle reaches have flooding and surcharging problems.

A number of habitat concerns exist in the watershed. In the downstream reaches, fish passage is blocked at 2nd Street during low flows and the channel is narrow and incised downstream of the railroad tracks. Canopy cover is mixed, with good tree cover in some areas and non-existent in others. In the middle reaches, the City has completed stream restoration projects at several locations within the watershed including Corvallis High School, Porter Park, and Jefferson Elementary School. Overall, instream and riparian habitat quality is low throughout the middle reaches and the quality of the canopy cover varies. In both the lower and middle reaches, water quality may be degraded due to untreated stormwater runoff from parking lots. Canopy cover and fish habitat improve in the upper reaches and headwaters of Dixon Creek.

Opportunities exist for preserving headwater areas not yet impacted by development. Other locations, including along Walnut Boulevard in the vicinity of the Northwest Hills Baptist Church, may provide opportunities for stream enhancement and water quality improvement. End-of-pipe stormwater treatment may be appropriate at several stormwater discharge locations. City access to the stream is compromised by private property ownership that extends to the centerline of the stream at many locations.

6.3 WATERSHED MANAGEMENT OPTIONS

Recommendations for the Dixon Creek watershed are shown in Table 6-3.

The recommended options vary considerably from reach to reach. In the lower reaches, higher stream velocities and commercial development along the stream banks have led to an emphasis on stabilizing streambanks, re-establishing canopy cover, and minimizing fish passage issues with culverts. In its middle reaches, Dixon Creek is a tightly confined channel running through largely residential neighborhoods. Many of the recommendations for the middle reaches focus on ways to change public behavior, such as crafting citywide ordinances and working with schools to develop examples of good riparian practices. The upper reaches of Dixon Creek are not as intensively developed. Recommendations for this section emphasize preservation and enhancement of open space and habitat.

The consultant team and City staff identified three levels of watershed management options. Table 6-4 and Figure 6-3 show the recommendations and locations for the short-term management program, along with estimated costs.

Activities that can be implemented citywide through modifications and additions to current City code and development standards are summarized in Chapter 5. Recommended examples include development standards to reduce stormwater runoff quantity and to improve water quality, and measures to reduce construction-related erosion. Other citywide activities focus on public education and involvement, including the development of a stream stewardship program.

Table 6-5 and Figure 6-4 present the long-term recommendations and their locations. The options include more capital projects than the other management options. Many of the recommended activities require the construction of end-of-pipe treatment facilities to improve water quality. Other capital projects will improve streambank stability and improve fish passage.

Table 6-3. Dixon Creek Options

Reach	Abridged observations	Recommended activity	Timing
Willamette River to 3rd Street	1) High velocities have created areas of erosion at a number of locations.	a. Stabilize streambank slopes with matting and vegetation and provide a more natural stream configuration.	Long-term
		b. Develop and implement citywide guidelines for preventing additional runoff volume or excessive velocities into the stream.	Ongoing
	2) During summer months a stagnant pool exists upstream of culvert. No fish passage is possible at downstream end of culvert on 2nd Street during low-flow periods.	a. Adjust culvert elevations to address fish passage and stagnant pool issues or install low flow culvert.	Long-term
3rd Street to Railroad tracks	1) City staff has reported that the channel is narrow and incised throughout this reach. Modeled velocities exceed the erosion criteria.	a. Stabilize streambank and provide a more natural stream configuration.	Short-term
	2) This reach lacks adequate tree canopy shading.	a. Provide vegetation to improve canopy cover.	Short-term
	3) Fish passage issues through culverts in this area will need to be addressed by ODOT.	a. Work with ODOT and ODFW to address fish passage issues.	Short-term
Railroad tracks to 9th Street	1) Overhead canopy coverage is very poor as noted by both City staff and the field investigation. The field investigation also found that overall instream and riparian habitat quality is extremely poor. Native herbaceous wetland species such as rushes and sedges (e.g. Scirpus sp.) occur along the channel bottom upstream of Reiman along with reed canarygrass and other weedy graminoids.	a. Provide plantings to increase shading on south side of stream where space allows.	Short-term
	2) The left bank (looking upstream) at Avery Square is experiencing erosion and bank failure, as is the right bank downstream of Reiman Avenue. Modeled stream velocities exceed criteria.	a. Will require land dedication from private landowner, and stabilize existing slope.	Short-term

Table 6-3. Dixon Creek Options (continued)

Reach	Abridged observations	Recommended activity	Timing
Railroad tracks to 9th Street (cont.)	3) Stormwater runoff entering stream directly from the Avery Square parking lot may contribute to water quality degradation.	a. Install structural stormwater treatment facilities to treat water from Avery Square parking lot.	Long-term
		b. Develop citywide guidelines for treatment of parking lot runoff.	Ongoing
9th Street to Buchanan Avenue	1) It has been reported that a 40-year old house 20 feet from creek is slowly settling from unknown causes.	a. Monitor streambank and house elevations.	Short-term
	2) A City sanitary sewer constructed of 12-inch diameter steel pipe and rubble cover form a low weir with a 1.5-foot drop about 125 feet downstream of 11th Street. This blockage creates fish passage and water temperature issues.	a. Investigate potential of creating a slot in the concrete cap of the sanitary sewer to reduce water surface elevation of water backing up behind blockage or provide stream channel improvements to allow fish to pass blockage.	Short-term
	3) Stormwater runoff from high school property discharges directly to stream with potential water quality degradation.	a. Install structural stormwater treatment facilities to treat runoff from high school.	Long-term
		b. Develop citywide guidelines for treatment for parking lot runoff.	Ongoing
		c. Work with high school to modify groundskeeping and create buffer strip along the stream.	Short-term
	4) Overall instream and riparian habitat quality is low.	a. Develop citywide guidelines for improving stream and riparian habitat.	Ongoing
		b. Improve riparian area through establishment of native vegetation.	Short-term
	5) A revetment composed of demolition debris is located at the bend downstream of 10th Street.	a. Replace demolition debris with stream stabilization and vegetation at bend downstream of 10th Street.	Short-term
	6) Steep streambanks failing at bend upstream of 9th Street. Modeled velocities exceed erosion criteria.	a. Stabilize streambank and provide a more natural stream configuration.	Short-term

Table 6-3. Dixon Creek Options (continued)

Reach	Abridged observations	Recommended activity	Timing
9th Street to Buchanan Avenue (cont.)	7) Fine sized sediment deposits accumulate upstream of 9th Street due to the low stream gradient.	a. Remove sediment upstream of 9th Street and monitor to determine source.	Short-term
		b. Develop citywide guidelines to reduce sources of construction site erosion and prevent streambank erosion.	Ongoing
	8) Large storm drain discharging in this reach may degrade water quality.	a. Install end-of-pipe technology for treating stormwater.	Long-term
		b. Develop citywide guidelines for improving the water quality of parking lot runoff through treatment.	Ongoing
	9) The pipe system along Buchanan Avenue and upstream is undersized for the 10-year storm.	a. Replace pipes along Buchanan Avenue, Kings Boulevard, and Grant Avenue.	Short-term
Buchanan Avenue to Grant Avenue	1) Citizen wants an engineer (from City) to visit and observe erosion of stream bank. City staff reports property owners restoring section of stream. Erosion is undercutting the west bank between Beca Avenue and Buchanan Avenue. Modeled velocities exceed erosion criteria.	a. Coordinate with private property owners on stream restoration in this reach (supply materials and expertise).	Long-term
	2) Ponding of water occurs at an instream concrete obstruction at 15th Street and Lincoln Avenue.	a. Pinpoint location and remove concrete obstruction if no adverse effects will result.	Short-term
	3) Overall instream and riparian habitat quality is low.	a. Develop citywide guidelines for improving stream and riparian habitat.	Ongoing
		b. Coordinate with private property owners' restoration project (supply materials and expertise).	Long-term
	4) Excessive sediment accumulation at Buchanan Avenue.	a. Remove sediment from culvert and monitor to determine source.	Long-term
		b. Develop citywide guidelines to reduce sources of construction site erosion and prevent streambank erosion.	Ongoing

Table 6-3. Dixon Creek Options (continued)

Reach	Abridged observations	Recommended activity	Timing
Grant Avenue to Garfield Avenue	1) In vicinity of 13th Street and Greeley Avenue, there is localized flooding that goes up and down with stream.	a. Monitor extent and duration of flooding near 13th and Greeley.	Short-term
	2) Vista Place (near Grant Avenue and 15th Street) had high water in street during the February 1996 storm. The City's Flood Mitigation Program appears to have addressed the hydraulic restrictions.	a. Monitor stream levels at Vista Place to confirm success of flood mitigation project.	Short-term
	3) Overall instream and riparian habitat quality is low.	a. Develop citywide guidelines for improving stream and riparian habitat.	Ongoing
		b. Improve riparian area through plantings along stream.	Long-term
Garfield Avenue to Kings Boulevard	1) Near Arthur Circle, concern about rapid rise in creek, even for smaller storm events. The February 1996 storm caused high water and closed roads in several locations along Arthur Circle.	a. Monitor stream levels at Arthur Circle to confirm success of flood mitigation project.	Short-term
	2) Overall instream and riparian habitat quality is low. Channel is confined, but appears to have excess capacity near Garfield Avenue.	a. Develop citywide guidelines for improving stream and riparian habitat.	Ongoing
		b. Extend habitat improvements upstream of Porter Park by placing large woody debris in channel upstream of Garfield Avenue (after confirming success of flood mitigation effort at Arthur Circle).	Long-term
	3) Flooding complaints have been received from property owners along Kings Boulevard north of Dixon Creek. Modeling shows an undersized pipe between Elmwood Drive and Larch Avenue. City staff has expressed concern that this large storm drain may degrade instream water quality.	a. Replace the affected pipes along Kings Boulevard between Larch Avenue and Dixon Creek and install end-of-pipe technology for treating storm water.	Long-term
		b. Develop citywide guidelines for improving the water quality of parking lot runoff through treatment.	Ongoing

Table 6-3. Dixon Creek Options (continued)

Reach	Abridged observations	Recommended activity	Timing
Kings Boulevard to Circle Boulevard	1) City staff reported that instream water quality might be degraded by the large storm drain along Circle Boulevard. Water flowing from manholes has flooded the street for short periods during large storms. Modeling shows the pipe that discharges from Circle Boulevard to Dixon Creek is undersized for both existing and future conditions.	a. Replace undersized pipe and install end-of-pipe technology for treating storm water.	Long-term
		b. Develop citywide guidelines for improving the water quality of parking lot runoff through treatment.	Ongoing
	2) Excessive sedimentation was found in culvert at Circle Boulevard.	a. Remove sediment from culvert and monitor to determine upstream sources.	Long-term
		b. Develop citywide guidelines to reduce erosion of sediment into stream and to stabilize stream banks.	Ongoing
	3) The overhead cover and aquatic habitat are better than many other reaches along this stream. However, the overall instream and riparian habitat conditions are degraded.	a. Develop citywide guidelines for improving instream water quality.	Ongoing
		b. Develop citywide guidelines for improving stream and riparian habitat.	Ongoing
	4) A large area of under-utilized, publicly owned open space at school site immediately adjacent to the stream provides a potentially valuable opportunity to create a relatively large passive flood storage facility. This can be a true multi-objective urban stream rehabilitation project, with habitat, recreational, and visual improvements readily integrated into the flood alleviation design.	a. Construct multi-use riparian facility to provide water quality/detention benefits with cooperation of school district.	Short-term
Circle Boulevard to 29th Street	1) Public has noted loss of wildlife in area.	a. Develop citywide guidelines for riparian protection.	Ongoing
	2) City staff has noted some streambank erosion in this reach. Telephone poles are being used in one segment of the stream to help protect the banks. Modeled velocities exceed the erosion criteria. The field investigation reported grass-covered flood benches with significant undercut banks.	a. Provide public information to promote stream stewardship activities and to discourage activities with potential negative effects.	Ongoing
		b. Pinpoint the erosion problems and stabilize streambanks using log cribs and vegetative techniques where walls aren't required.	Long-term

Table 6-3. Dixon Creek Options (continued)

Reach	Abridged observations	Recommended activity	Timing
	3) The box culverts at 27th Street limit fish passage.	a. Improve culverts to allow fish passage.	Long-term
	4) Closely spaced alders form a significant channel pinch point at 29th Street.	a. Monitor situation to determine if pinch point is contributing to local flooding problems.	Short-term
	5) Modeling shows the channel upstream of Elmwood Drive to be undersized. Field investigations reported houses close to channel and privately constructed walls and other structures constricting the channel.	a. Remove encroaching structures where needed to increase channel cross-section.	Short-term
29th Street to Walnut Boulevard (West Branch)	1) Drainage from Roosevelt to Taft has created flooding in houses and basements. It appears that the Oak Creek drainage (Skyline West) is going into Dixon Basin. Could this be re-routed to Oak?	a. Continue to monitor, modeling does not show a problem in this area. Determine size of storm to initiate flooding and the extent of flooding under this scenario.	Short-term
	2) The large parking lot at the Northwest Hills Baptist Church may be contributing to water quality degradation.	a. Public information and institutional cooperation could present stream stewardship opportunities.	Ongoing
		b. Develop citywide guidelines for improving the water quality of parking lot runoff through treatment.	Ongoing
	3) Bank and channel erosion was observed at locations along Walnut Boulevard, upstream of 29th Street behind Hoover School and the Northwest Hills Baptist Church. Modeled velocities exceed the erosion criteria.	a. Pinpoint erosion and stabilize streambanks using vegetative techniques. Replant streambanks with native vegetation.	Short-term
		b. Develop citywide guidelines for preventing additional runoff volume and excessive velocities into the stream.	Ongoing
	4) Modeling shows an undersized culvert at Walnut Place.	a. Replace culvert.	Short-term
	5) Modeling shows an undersized culvert at Witham Village.	a. Replace culvert.	Short-term

Table 6-3. Dixon Creek Options (continued)

Reach	Abridged observations	Recommended activity	Timing
Walnut Boulevard to Headwaters (West Branch)	1) A portion of the drainage system originates in the County.	a. Coordinate City and County development standards in this area to help protect quality of stream and riparian habitat.	Ongoing
	2) Modeling shows an undersized culvert at Walnut Boulevard.	a. Replace culvert.	Short-term
	3) Modeling shows an undersized culvert at Live Oak Drive.	a. Replace culvert.	Short-term
	4) City staff has reported erosion concerns along Glenridge Drive between Walnut Boulevard and Ponderosa Avenue. Modeled velocities exceed the erosion criteria at this point.	a. Stabilize channel using vegetative means.	Long-term
	5) Modeled velocities exceed the erosion criteria near Live Oak Drive, but the channel has not been inspected.	a. Preserve and enhance riparian vegetation to decrease runoff volume and velocities.	Short-term
Walnut Boulevard to Arrowood Circle Headwaters (Middle Branch)	1) Summer flow is polluting the Timberhill area Dixon tributaries.	a. City staff to monitor extent of problem.	Short-term
	2) Drainage on street not properly located near Arrowood. Flows from West Fork west to other tributary.	a. City staff to monitor extent of problem.	Short-term
	3) North Fork channel was filled with sediment. North Fork used to be main channel; now channel to the west is the larger channel.	a. Develop citywide guidelines to reduce erosion of sediment into stream and to stabilize stream banks.	Ongoing
	4) An old detention facility has filled with silt.	a. Allow facility to remain filled with silt. Enhance wetland aspects of facility to improve water quality and riparian area.	Short-term
	5) Model results show stream velocities between Twinberry Place and Huckleberry Place exceed the erosion criteria, but these sections have not been inspected.	a. Regrade streambanks in greenway to a lower angle, replant with native woody vegetation, construct rock check dams.	Short-term
		b. Develop citywide guidelines for preventing additional runoff volume and excessive velocities into the stream.	Ongoing

Table 6-3. Dixon Creek Options (continued)

Reach	Abridged observations	Recommended activity	Timing
Walnut Boulevard to Arrowood Circle Headwaters (Middle Branch) (cont.)	6) Channel degradation and chronic sediment source in 300-foot segment upstream of Arrowood Circle near Sitka Place.	a. Regrade streambanks upstream of Sitka Place to a lower angle, replant with native woody vegetation, construct rock check dams.	Short-term
	7) Modeling shows the channel along Walnut Boulevard upstream of the detention facility is undersized.	a. Layback channel to provide greater capacity.	Short-term
	8) Modeling shows the culvert at Arrowood Circle near Sitka Place is undersized.	a. Replace culvert.	Short-term
	9) Modeling shows the culvert at Arrowood Circle between Boxwood Place and Snowbrush Place is undersized.	a. Replace culvert.	Short-term
	10) Modeling shows the culvert at Arrowood Circle near Snowbrush Place is undersized.	a. Replace culvert.	Short-term
29th Street to Headwaters in Chip Ross Park (East Branch)	1) Springs all over the hillsides are the source of stream flow in the upper reaches of Dixon Creek. They may cause erosion problems with exposed soil from new development. The Timberhill area is yet to be developed and needs to have quality protection of ecological functions and values. Model results show velocities exceed the erosion criteria.	a. Develop citywide guidelines to reduce erosion of sediment into stream and to stabilize streambanks.	Ongoing
		b. Consider development of citywide guidelines to increase setbacks from stream and to provide added protection to streams and riparian area.	Ongoing

Table 6-4. Dixon Creek Short-Term Program

Reach	Recommended activity	Capital cost ($)	Annual O&M ($)	Project type[1]
3rd Street to Railroad tracks	1) Stabilize streambank and provide a more natural stream configuration.	60,000	3,000	
	2) Provide vegetation to improve canopy cover.	2,800	140	Orange line
	3) Work with ODOT and ODFW to address fish passage issues at Highway 99.	1,920	360	
Railroad tracks to 9th Street	1) Provide plantings on south side of stream to increase shading.	3,200	160	
	2) Stabilize streambank and provide a more natural stream configuration.	14,000	700	Green line
9th Street to Buchanan Avenue	1) Monitor streambank and house elevations.	NA	250	
	2) Create a slot in the concrete cap of the sanitary sewer downstream of 11th Street to reduce water surface elevation of water backing up behind blockage or provide stream channel improvements to allow fish to pass blockage.	2,000	360	
	3) Work with high school to modify groundskeeping and create buffer strip along stream.	1,920	NA	
	4) Improve riparian area through establishment of native vegetation as part of streambank stabilization projects.	12,000	600	
	5) Replace demolition debris downstream of 10th Street with vegetative streambank stabilization.	30,000	1,500	Green line
	6) Stabilize streambank and provide a more natural stream configuration.	7,000	350	Yellow line
	7) Remove sediment upstream of 9th Street and monitor to determine source.	NA	250	
	9) Replace undersized pipes along Buchanan Avenue, Kings Boulevard, and Grant Avenue.	757,000	NA	Red line
Buchanan Avenue to Grant Avenue	2) Remove obstruction near 15th Street and Lincoln Avenue.	5,000	NA	

[1]Project types are in the Figure 6-3 map legend.
NA = Not applicable.

Table 6-4. Dixon Creek Short-Term Program (continued)

Reach	Recommended activity	Capital cost ($)	Annual O&M ($)	Project type[1]
Grant Avenue to Garfield Avenue	1) Monitor stream levels at 13^{th} Street and Greeley Avenue to determine extent and duration of reported flooding.	NA	750	☑
	2) Monitor stream levels at Vista Place (near 15^{th} and Grant) to confirm success of flood mitigation project.	NA	750	☑
Garfield Avenue to Kings Boulevard	1) Monitor stream levels at Arthur Circle to confirm success of flood mitigation project.	NA	750	☑
Kings Boulevard to Circle Boulevard	4) Construct multi-use riparian facility to provide water quality/detention benefits in cooperation with the school district.	226,000	2,260	
Circle Boulevard to 29^{th} Street	4) Monitor situation to determine if pinch point near 29^{th} Street is contributing to local flooding problems.	NA	750	☑
	5) Remove encroaching structures, widen channel, and install rock walls where necessary to increase channel cross-section and capacity.	120,000	6,000	Yellow line
29^{th} Street to Walnut Boulevard (West Branch)	1) Continue to monitor, modeling does not show a problem in this area. Determine size of storm to initiate flooding and the extent of flooding under this scenario.	NA	1,300	☑
	3) Stabilize streambanks using vegetative techniques. Replant streambanks with native vegetation.	210,000	10,500	Green line
	4) Replace culvert at Walnut Place with 60-inch pipe.	14,900	NA	Red line
	5) Replace culvert at Witham Village with 42-inch pipe.	6,900	NA	Red line

[1]Project types are in the Figure 6-3 map legend.
NA = Not applicable.

Table 6-4. Dixon Creek Short-Term Program (continued)

Reach	Recommended activity	Capital cost ($)	Annual O&M ($)	Project type[1]
Walnut Boulevard to Headwaters (West Branch)	2) Replace culvert at Walnut Boulevard with 36-inch pipe.	16,600	NA	Red line
	3) Replace culvert at Live Oak Drive with 42-inch pipe.	4,700	NA	Red line
	5) Preserve and enhance riparian vegetation to decrease runoff volume and velocities.	196,000	9,800	
Walnut Boulevard to Arrowood Circle (Middle Branch)	1) City staff to monitor extent of summer flow pollution problem in headwaters.	NA	200	
	2) City staff to monitor extent of flows from Middle Fork to West Fork of Dixon Creek at Arrowood Circle.	NA	750	
	4) Allow facility to remain filled with silt. Consider wetland enhancement activities to improve water quality or riparian area.	5,000	1,100	
	5) Regrade streambanks in greenway to a lower angle, replant with native woody vegetation, construct rock check dams.	600,000	30,000	
	6) Regrade streambanks upstream of Sitka Place to a lower angle, replant with native woody vegetation, construct rock check dams.	60,000	3,000	
	7) Widen channel upstream of detention facility along Walnut Boulevard to provide greater capacity.	120,000	6,000	Yellow line
	8) Replace culvert at Arrowood Circle near Sitka Place.	13,600	NA	Red line
	9) Replace culvert at Arrowood Circle between Boxwood Place and Snowbrush Place.	8,700	NA	Red line
	10) Replace culvert at Arrowood Circle near Snowbrush Place.	7,300	NA	Red line
Total		**$2,506,540**	**$81,580**	

[1]Project types are in the Figure 6-3 map legend.
NA = Not applicable.

Table 6-5. Dixon Creek Long-Term Program

Reach	Recommended activity	Capital cost ($)	Annual O&M ($)	Project type[1]
Willamette River to 3rd Street	1) Stabilize streambank slopes using matting and vegetation.	28,000	1,400	Green line
	2) Adjust culvert elevations to address fish passage and stagnant pool issues or install low-flow culvert.	17,000	1,700	
Railroad tracks to 9th Street	3) Install structural stormwater treatment facilities to treat water from Avery Square parking lot.	20,000	2,200	
9th Street to Buchanan Avenue	3) Install structural stormwater treatment facilities to treat runoff from high school.	15,000	1,650	
	8) Install end-of-pipe technology for treating stormwater from Buchanan Avenue.	15,000	1,650	
Buchanan Avenue to Grant Avenue	1) Coordinate with private property owners on stream restoration to stabilize streambanks.	2,400	180	Green line
	3) Coordinate with private property owners to improve habitat.	1,200	NA	
	4) Remove sediment from culvert at Buchanan Avenue and monitor to determine source.	NA	275	
Grant Avenue to Garfield Avenue	3) Improve riparian area with native plantings throughout reach.	21,000	1,050	
Garfield Avenue to Kings Boulevard	2) Extend habitat upstream of Porter Park by placement of large wood debris.	6,000	300	
	3) Replace undersized pipe along Kings Boulevard and install end-of-pipe technology for treating storm water.	158,000	1,650	Red line
Kings Boulevard to Circle Boulevard	1) Replace undersized pipe along Circle Boulevard and install end-of-pipe technology for treating storm water.	106,000	1,650	Red line
	2) Remove sediment from culvert at Circle Boulevard and monitor effectiveness of upstream erosion controls.	NA	275	
Circle Boulevard to 29th Street	2) Stabilize streambanks with log cribs and vegetative techniques where walls not required.	7,000	350	Green line
	3) Improve culverts at 27th Street to allow fish passage past blockage.	3,800	190	
Walnut Boulevard to Headwaters (West Branch)	4) Stabilize channel along Glenridge Drive using vegetative means.	49,000	2,450	Green line
Total		**449,400**	**16,970**	

[1]Project types are in the Figure 6-4 map legend.
NA = Not applicable.

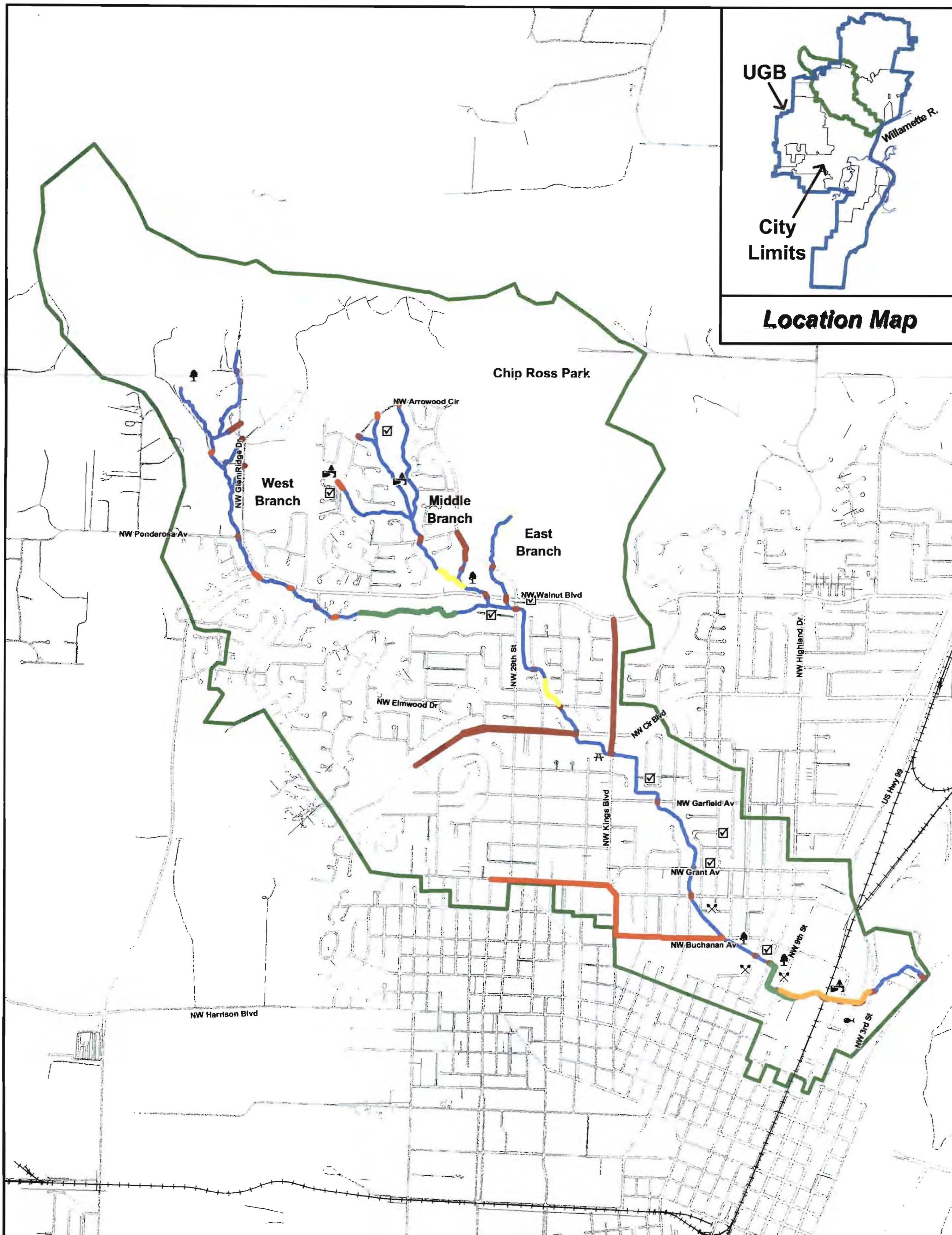


Figure 6-3 Short Term Project Locations

LEGEND

Pipes/Bridges	Channels	Basin Boundary
Bank Stabilization	Canopy Revegetation	Channel Improvement
Replace Pipe/Bridge	Fish Passage	Buffer/Riparian Habitat
Floodplain Reconnection	Treatment Facility	Flood Management Structure
Maintenance	Monitor	Multi-Use Facility

N

Feet 600 0 600 1200 1800 2400 Feet

CORVALLIS
ENHANCING COMMUNITY LIVABILITY
Public Works Department

BROWN AND CALDWELL
and Associated Firms

report/figures/Fig6-3v3.wor, October 12, 2000, base data from City of Corvallis GIS Department

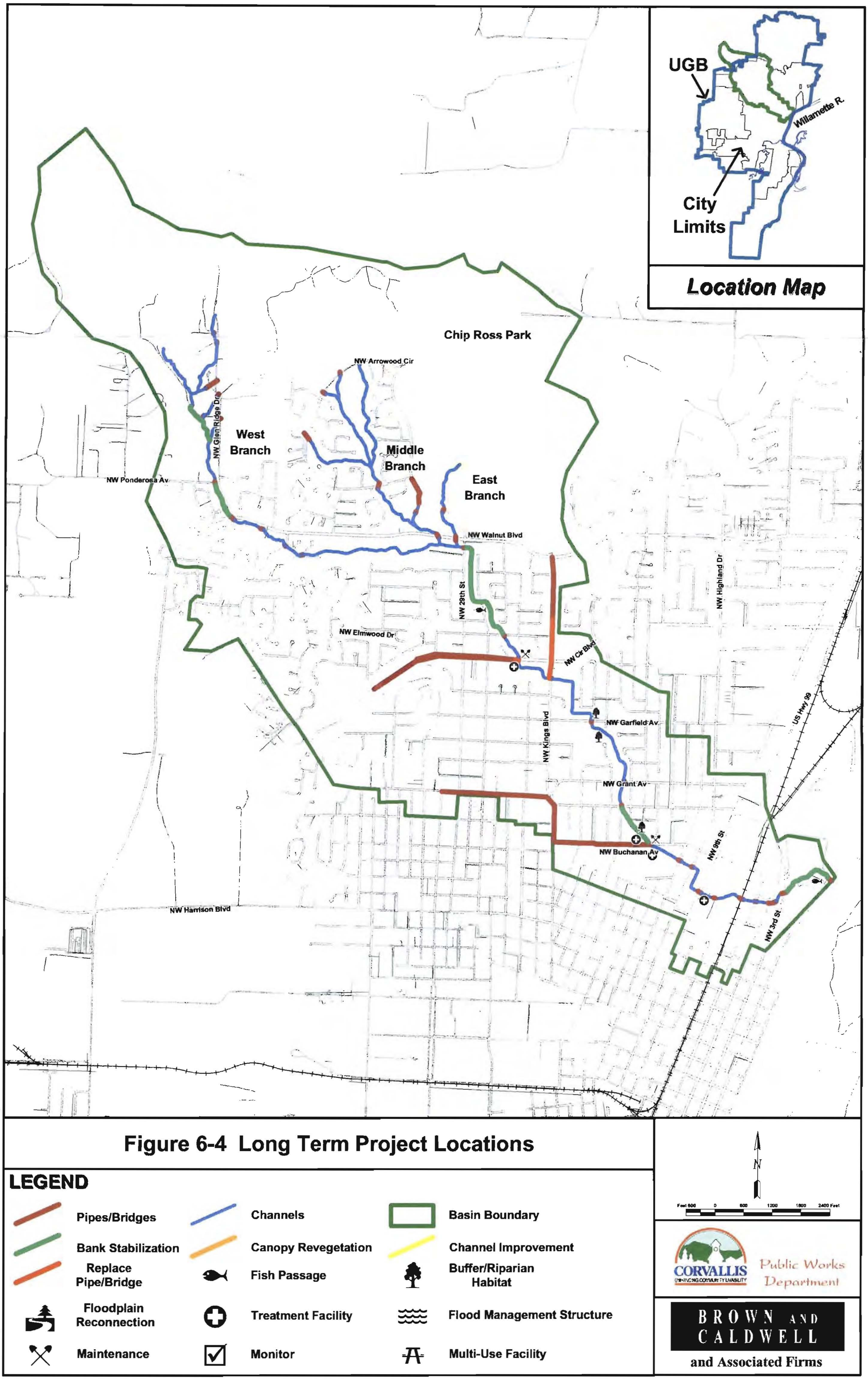


Figure 6-4 Long Term Project Locations

report/figures/Fig6-4v3.wor, October12, 2000, base data from City of Corvallis GIS Department

CHAPTER 7

WATERSHED PLANNING AND ANALYSIS: SQUAW CREEK

7.1 INTRODUCTION

Squaw Creek runs from Bald Hill Park west of Corvallis and eastward to its conjunction with Marys River at Brooklane Drive. The Squaw Creek watershed contains 2,363 acres. The largest land uses at present consist of low-density residential at 766 acres, and vacant land at 609 acres. There is some industrial and commercial land use in the watershed, although this is mostly limited to the Sunset Research Park and along Philomath Boulevard (Hwy 20/34). In the future, if the watershed is developed according to the City's Comprehensive Plan, all of the vacant land may be developed with most of it converted to residential land use. In addition, medium- and high-density dwellings will make up an increasingly larger portion of the residential land use. As a result of these changes in land use, the amount of impervious land may increase from 762 to 968 acres, an increase of 27 percent.

7.2 WATERSHED FINDINGS

Information on watershed conditions was obtained by collecting public comments at open houses, working with City staff to identify maintenance and operation problems, conducting a technical stream evaluation of selected reaches, and by modeling the conveyance system for the existing and build-out scenarios. This information was compiled by stream reach and is summarized in Section 7.2.5. A map of the Squaw Creek watershed, presented as Figure 7-1, shows the location of the stream within the City and identifies some of the major observations made during the watershed study.

The Squaw Creek watershed is relatively flat and erosion does not appear to be a significant issue. The low gradient has resulted in extensive areas lying within the 100-year floodplain and a large number of wetlands. Flooding is a concern along Squaw Creek. Figure 7-2, Photo 1, shows a low-lying area at Sunset Park with its small channel during normal conditions. Figure 7-2, Photo 2, shows approximately the same location during the February 1996 floods. The 1996 events also caused flooding further downstream at Knollbrook Place as shown in Figure 7-2, Photo 3.

Other issues within Squaw Creek include fish habitat and passage issues, such as the riprap barrier at Brooklane Drive, Figure 7-2, Photo 4. The Squaw Creek watershed also includes extensive parks, bike trails, and open spaces. There are pollution concerns (bacteria from duck wastes) in the Starker Arts Park (Figure 7-2, Photo 5). Recent maintenance efforts have cleared some of the accumulations of debris downstream of Knollbrook Place that impeded flows (Figure 7-2, Photo 6).

At present, Squaw Creek is less urbanized than other Corvallis watersheds, such as Dixon Creek or Sequoia Creek, but rapid development is occurring along the creek's western reaches, resulting in an increase in impervious surfaces. A key strategy for maintaining the health of the Squaw Creek watershed is to preserve and add to the relatively long lengths of natural stream corridor that currently exist along the creek mainstem and its tributaries.

7.2.1 Public Comments

Public input into the watershed planning process has been encouraged and facilitated through a number of public meetings. The first of these meetings was held on March 30, 1999, and the second on April 8, 1999 at Western View Middle School. During those meetings, residents were encouraged to share their knowledge of problem areas and to identify opportunities for improving the health of the Squaw Creek watershed. Reach-specific comments provided by the public are in Section 7.2.5. Some general comments are provided below:

- "Marys River flooding has caused Squaw Creek to back up in the past."
- "Given backwater impact from Marys River, will retention cause a greater problem? Lower portions may need different standards."
- "Piers on Marys River cause several inches of backwater."
- "Should protect natural areas (including wetlands). Natural areas promote wildlife."
- "Squaw Creek subdivision caused channelization. Slow, meanders in the channel may be hindering flows."

7.2.2 City Staff Reports

City Engineering and Utilities Operation staff is familiar with most of the Squaw Creek watershed through their day-to-day activities. They provided input into the planning process by identifying known problem areas, recommending areas for stream enhancement activities, and recounting the extent and duration of flooding during major storm events. For example, the extent of flooding from the February 1996 storm was well documented. During that storm, road closures were reported at several locations from Brooklane Drive to 53rd Street.

7.2.3 Field Study Observations

As part of this project, Watershed Applications, a stream rehabilitation specialty firm, conducted a series of field investigations beginning in November 1997. A summary of their observations is in Section 7.2.5. Detailed descriptions of the field study observations are in Appendix B. The Knollbrook area of Squaw Creek was revisited as part of the City's Flood Mitigation Study in 1999.

7.2.4 Modeling Results

A computer model for the Squaw Creek watershed identified the hydraulic capacity and projected flows in the pipes, culverts, and channels of the conveyance system for existing and future build-out scenarios. Existing conditions are based on the current level of development at the time of modeling. Build-out conditions are based on full development of the watershed in the future as identified

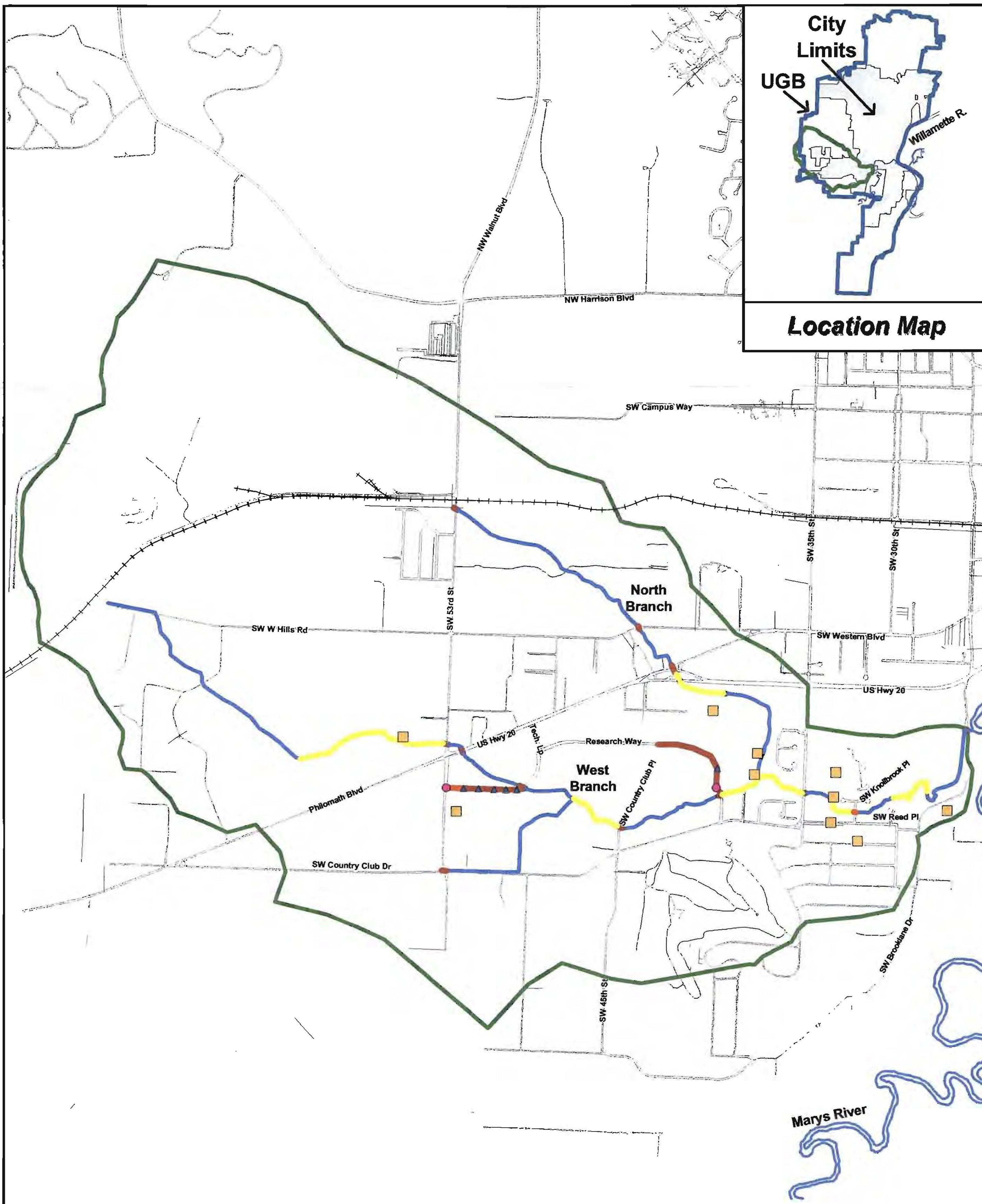


Figure 7-1 Squaw Creek Problem Areas

LEGEND

- Pipes/Bridges
- Channels
- Basin Boundary
- Reported Problems (recorded at open house)
- Surcharged Manholes (10-year future storm)
- Flooded Manholes (10-year future storm)
- High Velocity Areas (> 4 fps, 2-year future storm)
- Undersized Conduits (10-year future storm)
- Undersized Channels (10-year future storm)

CORVALLIS ENHANCING COMMUNITY LIVABILITY Public Works Department

BROWN AND CALDWELL and Associated Firms

report/figures/final/fig7-1.wor, October 20, 2000, base data from City of Corvallis GIS Department

Figure 7-2. Watershed Photos

Photo 1. Sunset Park ball fields under normal conditions.

Photo 2. Flooding at Sunset Park ball fields

Photo 3. Flooding downstream of Knollbrook Place

Photo 4. Fish passage concern at Brooklane Drive

Photo 5. Bacteria concerns at Starker Arts Pond

Photo 6. Stream blockage downstream of Knollbrook Place

in the City's Comprehensive Plan. A full range of storm events was modeled for the existing and future scenarios, including the 2-, 10-, 25-, and 100-year storm events.

Table 7-1 shows the hydraulic structures (pipes, culverts, bridge crossings, etc.) that are undersized for the City's 10-year design storm. Undersized structures are defined as being surcharged (under pressure) or experiencing flooding. In some cases a structure may be surcharged due to effects from a downstream constriction that results in backwater, rather than too much flow from upstream. Recommendations to address the undersized structures are in Section 7.3 of this chapter. A complete summary of all modeled segments is in Appendix C.

Flooding of the Marys River impacts the capacity of the lower reaches of Squaw Creek. For example, the Marys River 100-year floodwater elevation covers the area up to an elevation of 225 feet; consequently, the capacity of the channels downstream and immediately upstream of elevation 225 is reduced. The model was constructed to determine the capacity of the channel with and without the backwater effects of Marys River during flood stage.

The modeling results shown in Tables 7-1 and 7-2 are for Squaw Creek without impacts from Marys River floodwaters. The modeling shows eight channel sections where water elevations from the design storm will overtop the streambank. At several of these locations, the channel cross-sections used in the model were estimated, since surveyed cross-section information was not available. The piped systems along 35th Street to Country Club Place and Technology Loop to 53rd Street are shown as undersized due to instream high water conditions.

Table 7-1. Modeled Flow for Undersized Hydraulic Structures within the Squaw Creek Watershed, cubic feet per second

Reach/Location/Model segment	Full pipe or channel capacity[1]	10-year storm flows		Flooding predicted by model	Flooding reported by staff or public
		Existing	Future		
Marys River to Reed Place/ Overflow in channel downstream of Reed Place/SQW010	84	174	174	Yes	Yes
Reed Place to 35th Street/Overflow in channel between Reed Place and Knollbrook Place/SQW015	225	232	232	Yes	Yes
Reed Place to 35th Street/ Undersize bridge at Knollbrook Place/ SQW020	276	204	204	Yes	Yes
35th Street to Country Club Place (West Branch)/ Overflow in channel between 35th Place and Research Way/ SQW035	65	373	373	Yes	Yes
35th Street to Country Club Place (West Branch)/ Overflow in channel between 35th Place and Research Way/ SQW040	27	194	196	Yes	Yes
35th Street to Country Club Place (West Branch)/ Undersized pipe along Research Way/SQW175	24	5.0	5.2	Yes	No
35th Street to Country Club Place (West Branch)/ Undersized pipe along Research Way that outfalls into stream/SQW170	25	8.7	9.0	Yes	No
Country Club Place to Technology Loop (West Branch)/Overflow in channel at Sunset Park ball fields/SQW060	118	175	179	Yes	Yes
Technology Loop to 53rd Street (West Branch)/ Undersized pipe at 53rd Street and Technology Loop/SQW120	5.4	8.6	8.6	Yes	No
Technology Loop to 53rd Street (West Branch)/ Undersized pipe along Technology Loop/SQW110	9.0	8.6	8.6	No	No
Technology Loop to 53rd Street (West Branch)/ Undersized pipe along Technology Loop/SQW105	14	8.5	8.4[2]	No	No
Technology Loop to 53rd Street (West Branch)/ Undersized pipe along Technology Loop/SQW100	15	8.5	8.4[2]	No	No
Technology Loop to 53rd Street (West Branch)/ Undersized pipe along Technology Loop/SQW095	14	8.5	8.4[2]	No	No
Technology Loop to 53rd Street (West Branch)/ Undersized pipe along Technology Loop that outfalls into stream/SQW090	25	8.5	8.4[2]	No	No
53rd Street to Headwaters (West Branch)/ Overflow in channel upstream of 53rd Street/ SQW150	48	86	87	Yes	Yes
Confluence with West Branch to Philomath Boulevard (North Branch)/ Overflow in channel at ODOT facility/SQW210	105	167	171	Yes	Yes
Philomath Boulevard to West Hills Road (North Branch)/Overflow in channel at Philomath Boulevard/SQW220	13	169	173	Yes	Yes

[1] The full pipe or channel capacity is based on Manning's equation. It does not account for a reduced hydraulic capacity resulting from downstream constrictions that may cause backwater conditions.

[2] The apparent decrease in flows in within the model tolerance. The higher flow should be used for design purposes.

The hydrologic/hydraulic model also estimated velocities occurring in channel segments to determine areas at risk for channel or streambank erosion. The velocities during the 2-year storm—the storm size most responsible for determining the channel configuration—were compared to the velocity criteria presented in Chapter 3. In general, the criteria identify that velocities in excess of 4 feet per second may cause erosion of the streambank or streambed. There were no segments with velocities in excess of the criteria.

Water elevations predicted by the model were compared to surveyed channel cross-sections to assess points of flooding along the open channels. Reaches where flows from the 10-year storm event overtop the base channel were identified as undersized channels in Figure 7-1. Recommendations for these reaches varied. If the overtopping would flood an area containing vulnerable structures, such as buildings, a recommendation was made to reduce the flooding. If the flooding was confined to an undeveloped area, recommendations for preservation, enhancement, and reconnection of the channel and floodplain were made.

The model showed eight segments where the design storm flows (10-year storm event) would overtop the streambanks. The segments from Marys River to Knollbrook Place are predicted to flood, as are segments within the following reaches: 35th Street to Country Club Place, Country Club Place to Technology Loop, upstream of 53rd Street along the west branch of the stream, the confluence of the west and north branches up to Philomath Boulevard, and Philomath Boulevard to West Hills Road. All of these segments reported high water or road closings during the February 1996 storm. In the areas upstream of Knollbrook Place, there appears to be enough overbank storage available to prevent flooding of roads or houses.

7.2.5 Stream Reach Summaries

For study purposes, Squaw Creek was divided into a number of reaches based on physical characteristics of the stream, property ownership, and any other unique characteristics that might distinguish one section of the stream from the rest. The study findings are summarized in the following sections by reach description. The public comments are shown as they were recorded during public meetings.

Marys River to Reed Place

Public Comments: "Brooklane – barriers too close to stream, development encroached on stream."

"Low areas along stream. Water seems to leave Marys River and run across Brooklane under high-flow conditions. House sinking on west side. Erosion along outside meander. Floods in 1996 had higher levels. Over bridge and into houses. Used to be crawdads, nothing now. Wood ducks, kingfisher, woodpeckers, nutria."

City Staff Reports: Brooklane Drive flooded in 1996. Backwater from Marys River causes flooding during extreme events. This section of the stream has poor canopy cover from Marys River up through the riprapped channel that extends 300 feet upstream of Brooklane Drive. The streambed in the area of the riprapped channel is of poor quality and needs improvement to provide better habitat.

Field Observations: A concrete structure near the Brooklane Drive bridge creates a 4-foot vertical drop in the channel that is a fish passage barrier. The stream channel has a number of sharp meanders in the area near Reed Place that affect hydraulic capacity. Himalayan Blackberry is present at multiple locations on the banks and overbank areas. Debris at the top of the banks in the wooded area may impede flows during high-flow events. The channel has incised over time, exposing soft bedrock at a number of locations. Some lateral undercutting of the banks is apparent.

Modeling Results: Modeling shows flooding during the 10-year storm event due to the channel configuration near Reed Place. Modeled velocities during the 2-year storm event are below the 4-feet-per-second criteria. This reach is in the Marys River 100-year floodplain. During high river flows, the water surface elevation reaches 225 feet above mean sea level. As a result of this backwater condition, the water surface elevation throughout the downstream reaches of Squaw Creek will be impacted by Marys River flood events.

Reed Place to 35th Street

Public Comments: "Knollbrook Bridge flooded because of intense rainfall."

"1676 S.W. Knollbrook. Flooding in 1996."

"1689 S.W. Knollbrook. Pipes under bridge collect debris. Need more capacity."

"3255 S.W. Knollbrook. Three inches in garage. Storm drain back flows into street."

"Vernal pool on school (Western View Middle School) stays wet through June."

"3403 S.W. Knollbrook. One and a half acres that crosses creek. Part across the creek is useless, would the city like to use it? Twenty years ago could jump across channel, now is much wider."

City Staff Reports: The area flooded during the 1996 storm, including high water at the intersection of Willamette Avenue and Longhill Street, and high water at the low areas around the Knollbrook Place bridge. The quality of the canopy in this reach varies. Many of the property owners in this reach mow vegetation to the top of bank or to the summer flow water surface elevation. The Adams School property (north bank of Squaw Creek) is mowed down to the summer channel, limiting habitat value and affecting wetlands area.

Field Observations: The stream becomes more incised in the downstream direction with bank erosion at selected locations. Encroachment by houses is limited to just a few properties within this reach due to the generally wide setbacks. The stream flows through a wet area at the edge of the Adams School grounds. This 600-foot area appears to be little used by the school, but habitat value is limited by groundskeepers mowing to the top of the bank. The south side banks are oversteep and failing in places near the Knollbrook Christian Reformed Church property. Near Knollbrook Place the floodplain is narrow, although functional, with supporting stands of sedges and buttercups toward its downstream end. The clay streambanks show minimal erosion near Knollbrook Place. Canopy coverage is of moderate quality due to the discontinuity of the stands and the relatively young native trees in the riparian area.

Modeling Results: Modeling shows flooding occurs in this reach due to backwater effects from the downstream channel configuration during the 10-year storm event. The bridge at Knollbrook Place appears to be undersized as well. Velocities are below the 4-fps criteria for the 2-year storm event due to the low gradient of the streambed.

35th Street to Country Club Place (West Branch)

Public Comments: "Wetland between Country Club and Research Way—will it be preserved?"

City Staff Reports: The February 1996 storm caused high water along Country Club Drive from 49th Street to Martin Street. The duck population at Starker Arts Park pond may be the source of bacteria pollution. Pet waste may also be a problem along the bike path that runs parallel to the creek.

Field Observations: At present, the 500-foot riparian area downstream of Country Club Place is a wet woodland and may be a jurisdictional wetland. It appears that the area was formerly a pasture or hay meadow. Drainage ditches from the golf course run down steep slopes until they run under Country Club Drive where the slope flattens out. Gradient transitions from steep to flat are often the cause of flooding problems. Drainage from the golf course is a potential pollutant source. Waterfowl in the Starker Arts Park pond are another pollution source. The 100-foot-long earthen ditch leading from the pond outlet to Squaw Creek could be converted into a bioswale to provide water treatment.

Modeling Results: The model shows the channel from 35th Street to Research Way is undersized for the 10-year storm event, although the flooding is restricted to wooded areas and does not threaten developed property. The drainage ditches from the golf course were not modeled. Parts of the stormwater collection system serving Research Way are undersized due to backwater conditions from Squaw Creek that reduce pipe capacity to below the 10-year design storm. Stream velocities in this reach are below the 4-feet-per-second criteria for the 2-year storm event.

Country Club Place to Technology Loop (West Branch)

Public Comments: No public comments on this reach.

City Staff Reports: The riparian corridor is narrow at several locations with poor or nonexistent canopy cover. Adjacent areas that may be wetlands are mowed. Runoff from the ball field parking lot enters the creek with no water quality protection.

Field Observations: The channel is not incised and the floodplain is unconstrained upstream of Country Club Place. The persistent wetness of this area indicates the presence of wetlands. Mowing practices in this reach restrict wildlife habitat potential. The channel appears stable throughout this reach, although the stream lacks the structural diversity for good habitat. The 1,100-foot section of stream that runs by the ball fields at Sunset Park offers an opportunity for riparian improvement/ restoration. There is a wide buffer area between the creek and the multi-unit housing complex on the right bank downstream of Technology Loop. The 600 feet of straightened channel affords the opportunity to enhance this area as a model for both habitat and aesthetic improvements.

Modeling Results: Modeling shows that 10-year storm event flows exceed the channel capacity and flood the overbank area at the ball fields in Sunset Park. The culverts downstream at Country Club Place are surcharged. Stream velocities in this reach are below the 4-feet-per-second criteria for the 2-year storm event.

Technology Loop to 53rd Street (West Branch)

Public Comments: "Do new parking lots such as Bi-Mart treat runoff?"

"Ditches have been deepened and weren't revegetated following widening of the bike lane—lots of erosion."

City Staff Reports: This reach has a narrow stream corridor with poor to nonexistent canopy. Adjacent wetland areas are mowed. Parking lot runoff from adjacent developed properties enters the creek with no water quality treatment. Culverts on Philomath Boulevard and 53rd Street present fish passage obstacles.

Field Observations: The stream channel is not incised through most of this reach. Canopy coverage is only fair, consisting of thick stands of small deciduous trees along most of the stream reach. The Bi-Mart/Safeway shopping complex is situated immediately next to the stream. The complex's large parking lot drains into inlets along the parking area periphery that are equipped with inverted elbows to remove oil and trash. The pipes drain into the stream through pipes equipped with flap gates.

Modeling Results: Manholes along the Technology Loop pipe system surcharge during the 10-year storm event, with the potential for flooding at the upstream end near 53rd Street, which may necessitate replacing the downstream pipes. Neither the public nor the City has reported surcharging in this area. Stream velocities in this reach are below the 4-feet-per-second criteria for the 2-year storm event.

53rd Street to Headwaters (West Branch)

Public Comments: Residents along Philomath Boulevard are interested in riparian enhancement opportunities upstream of 53rd Street.

"Concerned about stream widening out over large area and cutting new channels."

City Staff Reports: A DEQ hazardous clean-up site was located along the stream, and has been recently closed out. Benton County has purchased the property for development.

Field Observations: The stream and floodplain in the area approximately 500 feet upstream of 53rd Street consist of a wide, continuous riparian corridor of ash and hawthorn trees with considerable channel-spanning, downed woody debris (mostly smaller material). The channel in this reach is not incised nor is there significant bed or bank erosion. Although the canopy cover is good and riparian and instream habitat value is of good quality, this reach has potential for additional restoration.

Modeling Results: This reach was modeled up to West Hills Road. Modeling indicated that about one-half mile of channel upstream of 53rd Street is undersized for the 10-year storm event. The flooding does not impact any existing developed areas. Stream velocities in this reach are below the 4-feet-per-second criteria for the 2-year storm event.

Confluence with West Branch to Philomath Boulevard (North Branch)

Public Comments: "Vernal pond used by water fowl, frogs, herons, etc.—totally cool spot!"

"Ashbrook School removed sediment fence prior to revegetating the construction area and it is a constant, chronic source of sediment input directly into the creek."

"ODOT site committed to re-establishing a healthier reach of stream."

City Staff Reports: There is no protection between the maintenance area on ODOT property and the stream channel. The area floods frequently, covering the bike path, but this is natural for this flat area.

Field Observations: The ODOT maintenance facility has a large, graveled equipment yard abutting the creek near the bike path. The yard contains several potential pollutant sources, including tanks of paint, de-icer, and piles of gravel, with inadequate cover or containment. Leaks from truck and heavy equipment using the yard are also a concern. Vegetation along the yard edges may provide some filtration between the yard and the stream.

Modeling Results: Modeling shows that the channel is undersized for 700 feet downstream of Philomath Boulevard along the ODOT facility during the 10-year storm event. Stream velocities in this reach are below the 4-feet-per-second criteria for the 2-year storm event.

Philomath Boulevard to West Hills Road (North Branch)

Public Comments: "Highway 34 build up has increased flooding."

City Staff Reports: Multiple culverts under the highway may be an obstacle for fish passage. The stream corridor near Philomath Boulevard does not have a canopy and is mowed to the stream channel. Highway runoff discharges directly into the creek without treatment. The canopy upstream of the highway is good but the channel is very narrow. ODOT property is managed to protect the riparian habitat adjacent to the creek.

Field Observations: No field observation performed for this reach.

Modeling Results: Modeling shows the channel at the intersection of Western and Philomath Boulevards is undersized for the 10-year storm event due to its flat slope. Stream velocities in this reach are below the 4-feet-per-second criteria for the 2-year storm event.

West Hills Road to 53rd Street (North Branch)

Public Comments: No public comments on this reach.

City Staff Reports: Canopy cover is good in most places, although farming activities crowd the stream corridor.

Field Observations: No field observation performed for this reach.

Modeling Results: Hydraulic facilities within this reach are adequately sized for the design storms for existing and future build-out conditions. Stream velocities in this reach are below the 4-feet-per-second criteria for the 2-year storm event.

53rd Street to Headwaters (North Branch)

Public Comments: No public comments on this reach.

City Staff Reports: Flooding closed the roads at 53rd Street and Reservoir Road due to the February 1996 storm. A large pipe running along 53rd Street from the north needs to be investigated, as the County does not appear to have detailed records of it. Multiple culverts under 53rd Street, railroad tracks, and the Reservoir Road area may be a barrier for fish passage. The riparian corridor parallel to 53rd Street is narrow with average canopy value, and drainage in this area is not clearly defined. Runoff from agricultural properties is a source of pollutants (nutrients and bacteria from manure) during high runoff events. The Benton County Fairground parking lot drains directly into the creek with no treatment or buffer. The fairgrounds are a potential source of manure that could enter the creek during high runoff events. The industrial area on Reservoir Road does not have a stormwater runoff plan to help prevent pollutants from entering the creek.

Field Observations: A large amount of undeveloped land is located upstream of 53rd Street. Some of this land is publicly owned as part of Bald Hill Park. Several large ponds are present in the system behind the sawmill on Reservoir Road. These ponds are not believed to be hydraulically connected to Squaw Creek and were not directly observed.

Modeling Results: Except for the industrial area, most of this reach is outside of the city limits. Hydraulic capacity and velocities were not directly modeled for this reach of the stream, although runoff contributions from this area were included in the downstream modeling.

7.2.6 Watershed Summary

Squaw Creek has several reaches where flows overtop the channel banks during large storms. The sections with the most flooding impacts are the reaches between Brooklane Drive and 35th Street, where the sharply meandering channel and flat slopes reduce the stream's hydraulic capacity. In other areas, the flooding does not impact developed property, such as along 35th Street to Country Club Place, and 53rd Street to the headwater.

Fish passage is a concern at several locations within Squaw Creek. Under normal flow conditions, fish passage between Marys River and Squaw Creek is prevented by a 4-foot-high vertical wall in the channel near Brooklane Drive. Along the West Branch, the culverts beneath Philomath Boulevard and 53rd Street present a fish obstacle. City staff also identified potential problems with the culverts under the intersection of Western and Philomath Boulevards.

Pipe systems along Research Way and Technology Loop surcharge under the 10-year design storm. Backwater effects from Squaw Creek influence the capacity of both systems.

Squaw Creek contains a number of potential stream restoration or enhancement opportunities. Many of these opportunities are centered on the wooded wetlands that are common along the relatively flat stretches of Squaw Creek. Opportunities such as those in Sunset Park are especially noteworthy because they occur in publicly owned areas.

7.3 WATERSHED MANAGEMENT OPTIONS

Recommendations for the Squaw Creek watershed are shown in Table 7-3. The short-term program recommendations are shown in Table 7-4. They include restoring riparian habitat along several reaches, working with property owners of large parcels on water quality issues, and coordinating with ODOT in several locations.

The long-term program includes recommendations dealing with flooding in the lower reaches of the stream and a large riparian enhancement project at Sunset Park ball fields. Long-term projects are shown in Table 7-5.

Flooding along Squaw Creek near Knollbrook has been a longtime concern of residents. Information gathered during a City flood mitigation study in 1999 was incorporated into the current work. Simply widening the channel at this point was dismissed due to the close proximity of houses. An analysis of the detention required upstream to reduce the peak flows to prevent flooding showed that approximately 87 acre-feet of storage are needed. The available space is much less than what would be required and most of the available land is designated wetlands, which would cause wetland permitting challenges. Thus, a strategy of preserving existing upstream floodplain storage, floodproofing homes, and providing an overflow channel downstream was selected.

Table 7-3. Squaw Creek Options

Reach	Abridged observations	Recommended activity	Priority
Marys River to Reed Place	1) Marys River floods over Brooklane Drive under high-flow conditions.	a. Develop citywide requirements along with cooperate with Benton County and Marys River Watershed Council to improve upland stormwater management practices for reducing flows during larger storm events.	Ongoing
		b. City should establish floodplain policies, which include flood proofing, or purchase of properties in this area.	Long-term
	2) Erosion and subsidence problems, along with loss of wildlife species.	a. Develop citywide measures for preventing additional runoff volume or excessive velocities into the stream.	Ongoing
		b. Stabilize streambank and restore riparian habitat value. May require City purchase of adjacent lands.	Long-term
	3) Large areas filled with Himalayan Blackberry, an invasive, non-native plant. Poor canopy coverage and riprapped channel.	a. Restore habitat value by improving vegetative and native tree plantings along stream.	Short-term
	4) Concrete structure near Brooklane Drive bridge is a fish passage issue.	a. Develop and construct alternative to existing structure to remove fish barrier.	Short-term

Table 7-3. Squaw Creek Options (continued)

Reach	Abridged observations	Recommended activity	Priority
Reed Place to 35th Street	1) Channel erosion at several locations is creating more incised and wider channel.	a. Develop citywide measures for preventing additional runoff volume or excessive velocities into the stream.	Ongoing
		b. Stabilize streambank and provide for stream meander.	Long-term
	2) Sediment and debris collecting near Knollbrook Place bridge are reducing hydraulic capacity. Modeling shows the bridge is undersized.	a. Remove excessive accumulations of material from culvert.	Short-term
		b. Develop citywide measures for reducing erosion from construction sites.	Ongoing
		c. Work with the school district to re-establish floodplain downstream of 35th Street and stabilize slopes at up-stream eroded streambank locations.	Long-term
	3) Flooding in this reach of Squaw Creek due to back water effects and downstream constrictions.	a. Provide or require floodproofing of homes in this area.	Long-term
		b. Implement floodplain policies, which include flood proofing or purchase of properties in this area.	Ongoing
	4) Canopy cover is poor or lacking in some areas of this reach. Properties are mowed down to edge of low-flow channel.	a. Develop citywide requirements for improving stream and riparian habitat.	Ongoing
		b. Work with property owners to modify landscaping practices. Plant trees along south bank to provide shading. Use tree and shrub plantings to create riparian fringe along stream.	Short-term
	5) Large storms cause flooding near Knollbrook Place. Field studies show the channel capacity is limited due to tight meanders and large amounts of woody debris above normal water levels. Hydraulic modeling shows flooding near Knollbrook Place.	a. Create overflow channel for high flows along north side of channel.	Long-term

Table 7-3. Squaw Creek Options (continued)

Reach	Abridged observations	Recommended activity	Priority
35th Street to Country Club Place	1) Potential waterfowl pollution at Starker Arts Park Pond.	a. Convert the 100-foot long earthen ditch at pond outlet into a vegetated bioswale to provide filtration.	Short-term
	2) Several small drainage ditches may carry potential pollution from golf course into Squaw Creek.	a. Provide vegetative filtration to dechannelize lower ends of ditches. This would allow water to spread out into wooded wetland area.	Long-term
		b. Work with golf course to develop a chemical use minimization plan to reduce potential for fertilizer, herbicide and pesticide pollution.	Short-term
	3) Research Way pipe system has backwater problems, restricting capacity. No flooding complaints have been received.	a. Replace undersized pipes.	Long-term
	4) Model shows undersized channel from 35th Street to Research Way, approximately 1400 feet. Flooding appears restricted to wooded wetland area.	a. Preserve undeveloped area near channel. Reconnect channel to floodplain. Preserve and enhance vegetative buffer.	Long-term
	5) Flooding has occurred along Country Club Drive from 49th Street to Martin Street during larger storm events.	a. Develop citywide measures for preventing additional runoff volume or excessive velocities into the stream.	Ongoing
Country Club Place to Technology Loop (West Branch)	1) The riparian corridor is narrow at several locations with poor canopy cover. Mowing practices in this reach limit riparian habitat value.	a. Develop citywide requirements for improving stream and riparian habitat.	Ongoing
		b. Work with property owners to modify landscaping practices to improve habitat.	Short-term
	2) The runoff from the parking lots is minimally treated and presents risk to stream water quality.	a. Develop citywide water quality requirements for parking lot runoff.	Ongoing

Table 7-3. Squaw Creek Options (continued)

Reach	Abridged observations	Recommended activity	Priority
	3) Habitat is poor because straightened channel lacks canopy cover, woody debris, and is mowed to streambanks. Sunset Park is public land offering excellent opportunity to implement stream corridor rehabilitation project. Model shows flooding of channel at Sunset Park.	a. Regrade streambank to lower angle, reconnect stream to floodplain, and provide for stream meander. Design and construct stream and riparian enhancements as part of project.	Long-term
Technology Loop to 53rd Street (West Branch)	1) Concern over parking lot runoff from Bi-Mart/ Safeway shopping complex.	a. Work with shopping complex owners to identify additional on-site measures to protect stream water quality.	Short-term
	2) This reach has a narrow riparian corridor with poor canopy cover. Adjacent wetland areas are mowed.	a. Develop citywide requirements for improving stream and riparian habitat.	Ongoing
		b. Work with property owners to modify landscaping practices.	Short-term
	3) Culverts at Philomath Boulevard and 53rd Street may be a fish passage issue.	a. Investigate to see if culverts meet new ODOT/ODFW standards for fish passage.	Short-term
	4) Model shows undersized pipes in the Technology Loop collection system due to backwater from high flows in Squaw Creek. No complaints have been reported.	a. Replace undersized pipes along Technology Loop beginning at 53rd Street.	Long-term
53rd Street to Headwaters (West Branch)	1) The stream is getting wider and cutting new channels. Modeling shows 2500 feet of undersized channel upstream of 53rd Street.	a. Develop citywide measures for preventing additional runoff volume or excessive velocities into the stream.	Ongoing
		b. Preserve undeveloped area near channel. Improve overbank area to provide flow and storage capability while improving riparian zone.	Long-term
	2) Canopy cover and riparian area are of good quality. Landowners in area have indicated interest in working with City to restore habitat.	a. Develop citywide requirements to protect existing natural resources, including the stream and buffer areas.	Ongoing
		b. Implement stream stewardship program.	Ongoing

Table 7-3. Squaw Creek Options (continued)

Reach	Abridged observations	Recommended activity	Priority
Confluence with West Branch to Philomath Boulevard (North Branch)	1) Construction site erosion complaints have been recorded in this reach.	a. Develop citywide requirements for erosion control.	Ongoing
	2) ODOT is re-establishing a natural area located near their facility.	a. Coordinate with ODOT efforts, consider extending the restored natural area further downstream along bike trail.	Long-term
	3) No protection between ODOT maintenance area and stream.	a. Encourage ODOT to implement a stormwater pollution prevention plan (cover materials, limit runoff, etc.).	Short-term
		b. Widen vegetated buffer between ODOT site and stream.	Short-term
		c. Require implementation of citywide BMPs for all vehicle maintenance areas to reduce potential for water quality pollution.	Ongoing
	4) Modeling shows 700 feet of undersized channel downstream of Philomath Boulevard at ODOT facility. City staff notes that area floods frequently.	a. Increase channel capacity to prevent flooding and pollution from ODOT site. Coordinate with ODOT natural area.	Long-term
Philomath Boulevard to West Hills Road (North Branch)	1) Multiple culverts under highway may be barrier to fish passage.	a. Investigate to see if culverts meet new ODOT/ODFW standards for fish passage.	Short-term
	2) Stream corridor near highway has no canopy and is mowed to stream channel.	a. Work with ODOT to modify landscaping practices.	Short-term
	3) Modeling indicates undersized channel at intersection of Western and Philomath Boulevards.	a. Work with ODOT to ensure that culverts are well maintained (sediment removal). Replace culverts with larger ones if required as part of fish passage analysis.	Short-term
West Hills Road to 53rd Street (North Branch)	1) Farming activities crowd the stream corridor.	a. Work with County to require wide streamside buffers.	Short-term

Table 7-3. Squaw Creek Options (continued)

Reach	Abridged observations	Recommended activity	Priority
53rd Street to Headwaters (North Branch)	1) Intersection of 53rd Street and Reservoir Road is prone to flooding.	a. Work with Benton County and developers to protect existing upstream ponds and establish detention facilities.	Short-term
		b. Develop City and Countywide measures for preventing additional runoff volume or excessive velocities into the stream.	Ongoing
	2) Fish passage may be an issue at the 53rd Street and Reservoir Road culverts.	a. Investigate to see if culverts meet new ODOT/ODFW standards for fish passage.	Short-term
	3) Potential pollution from fairground parking lot and animal pens.	a. Route runoff through a vegetated swale that is regularly maintained.	Long-term
		b. Require roof and/or berm around animal pens to keep manure out of runoff.	Short-term
		c. Develop citywide requirements for treatment of parking lot runoff.	Ongoing
		d. Work with Benton County on requirements for treatment of runoff from animal storage facilities.	Ongoing
	4) Runoff from agricultural areas with livestock is a problem during storm events.	a. Establish riparian buffer and fence off stream to keep livestock out.	Short-term
		b. Develop citywide requirements for treatment of runoff from private animal storage facilities.	Ongoing
	5) Reservoir Road industrial area (sawmill) does not have a stormwater plan for preventing pollution.	a. Work with property owners to identify specific problems and potential solutions to protect water quality.	Long-term

Table 7-4. Squaw Creek Short-Term Program

Reach	Recommended activity	Capital cost ($)	Annual O&M ($)	Project type[1]
Marys River to Reed Place	3) Restore habitat value by improving vegetative and native tree plantings along stream.	45,000	2,300	
	4) Develop and construct alternative to existing structure to remove fish barrier.	100,000	5,000	
Reed Place to 35th Street	2) Remove excessive accumulations of material from culvert at Knollbrook Place.	NA	300	
	4) Work with property owners to modify landscaping practices. Plant trees along south bank to provide shading. Use tree and shrub plantings to create riparian fringe along stream.	1,000	NA	Orange line
35th Street to Country Club Place	1) Convert the 100-foot long earthen ditch at pond outlet into a vegetated bioswale to provide filtration.	1,600	300	
	2) Work with golf course to develop a chemical use minimization plan to reduce potential for fertilizer, herbicide and pesticide pollution.	400	NA	
Country Club Place to Technology Loop (West Branch)	1) Work with property owners to modify landscaping practices and improve habitat.	200	NA	
Technology Loop to 53rd Street (West Branch)	1) Work with shopping complex owners to identify additional on-site measures to protect water quality in stream.	400	NA	
	2) Work with property owners to modify landscaping practices. Plant trees along south bank to provide shading. Use tree and shrub plantings to create riparian fringe along stream.	1,800	NA	Orange line
	3) Investigate to see if culverts at Philomath Boulevard and 53rd Street meet new ODOT/ODFW standards for fish passage.	400	NA	
Confluence with West Branch to Philomath Boulevard (North Branch)	3) Encourage ODOT to implement a stormwater pollution prevention plan (cover materials, limit runoff, etc.).	NA	NA	
	3) Widen vegetated buffer between ODOT site and stream.	1,800	NA	

Table 7-4. Squaw Creek Short-Term Program (continued)

Reach	Recommended activity	Capital cost ($)	Annual O&M ($)	Project type[1]
Philomath Boulevard to West Hills Road (North Branch)	1) Investigate to see if culverts at Philomath Boulevard meet new ODOT/ODFW standards for fish passage.	400	NA	
	2) Work with ODOT to modify landscaping practices.	200	NA	Orange line
	3) Work with ODOT on sediment removal	200	NA	
West Hills Road to 53rd Street (North Branch)	1) Work with County to require wide streamside buffers.	200	NA	
53rd Street to Headwaters (North Branch)	1) Work with Benton County and developers to protect existing upstream ponds and establish detention facilities.	400	NA	
	2) Investigate to see if culverts meet new ODOT/ODFW standards for fish passage.	400	NA	
	3) Require controls to keep animal manure out of runoff.	400	NA	
	4) Establish riparian buffer and fence stream to keep livestock out.	NA	NA	
Total		**154,800**	**7,900**	

[1] Project types are in the Figure 7-3 map legend.

Table 7-5. Squaw Creek Long-Term Program

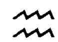
Reach	Recommended activity	Capital cost ($)	Annual O&M ($)	Project type[1]
Marys River to Reed Place.	1) Establish floodplain policies (purchase or flood proofing of homes with problems).	112,500	NA	
	2) Stabilize streambank and restore riparian habitat value. May require City purchase of adjacent lands.	21,000	1,100	
Reed Place to 35th Street	1) Stabilize streambank and provide for stream meander.	160,000	8,000	Yellow line
	2) Work with school to re-establish floodplain downstream of 35th Street and stabilize banks.	1,600	80	
	3) Provide or require floodproofing of homes in this area.	112,500	NA	
	5) Create overflow channel for high flows along north side of channel.	480,000	24,000	Yellow line
35th Street to Country Club Place	2) Provide vegetative filtration to dechannelize lower ends of ditches from golf course. This would allow water to spread out into wooded wetland area.	20,000	1,000	
	3) Replace undersized pipes along Research Way.	65,000	NA	Red line
	4) Reconnect channel to floodplain from 35th Street to Research Way. Work to preserve vegetative buffer.	280,000	14,000	
Country Club Place to Technology Loop (West Branch)	3) Design and construct stream and riparian enhancement project, including reconnection of channel to floodplain at Sunset Park.	300,000	15,000	
Technology Loop to 53rd Street (West Branch)	4) Replace undersized pipes along Technology Loop beginning at 53rd Street. Install structural stormwater treatment facilities at discharge to creek.	102,000	NA	Red line
53rd Street to Headwaters (West Branch)	1) Improve overbank area to provide flow and storage capabilities while enhancing riparian zone.	500,000	25,000	
Confluence with West Branch to Philomath Boulevard (North Branch)	1) Coordinate with ODOT efforts, consider extending the restored natural area further downstream along bike trail.	800	NA	
	4) Increase channel capacity. Coordinate with ODOT natural area.	140,000	7,000	Yellow line

Table 7-5. Squaw Creek Long-Term Program (continued)

Reach	Recommended activity	Capital cost ($)	Annual O&M ($)	Project type[1]
53rd Street to Headwaters (North Branch)	3) Route runoff from fairgrounds through a vegetated swale that is regularly maintained.	2,600	130	
	5) Work with property owners to identify specific problems and potential solutions to protect water quality.	600	NA	
Total		**2,298,600**	**95,310**	

[1]Project types are in the Figure 7-4 map legend.

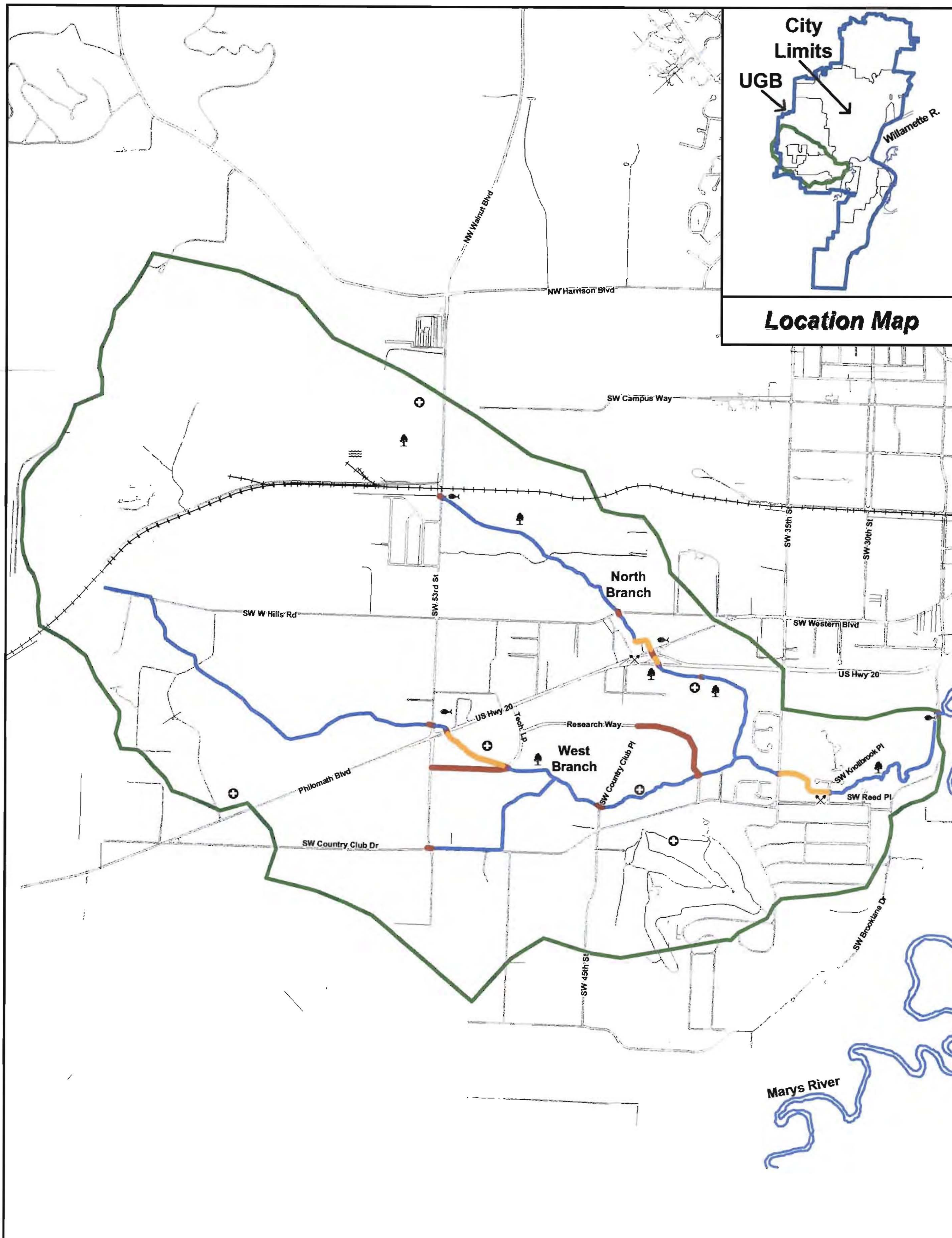


Figure 7-3 Short Term Project Locations

(see Table 7-4 for project descriptions)

LEGEND

- Pipes/Bridges
- Channels
- Basin Boundary
- Bank Stabilization
- Canopy Revegetation
- Channel Improvement
- Replace Pipe/Bridge
- Fish Passage
- Buffer/Riparian Habitat
- Floodplain Reconnection
- Water Quality BMP
- Flood BMP
- Maintenance
- Monitor
- Multi-Use Facility

N

Feet 600 0 600 1200 1800 2400 Feet

CORVALLIS ENHANCING COMMUNITY LIVABILITY

Public Works Department

BROWN AND CALDWELL

and Associated Firms

report/figures/final/fig7-3.wor, October 20, 2000, base data from City of Corvallis GIS Department

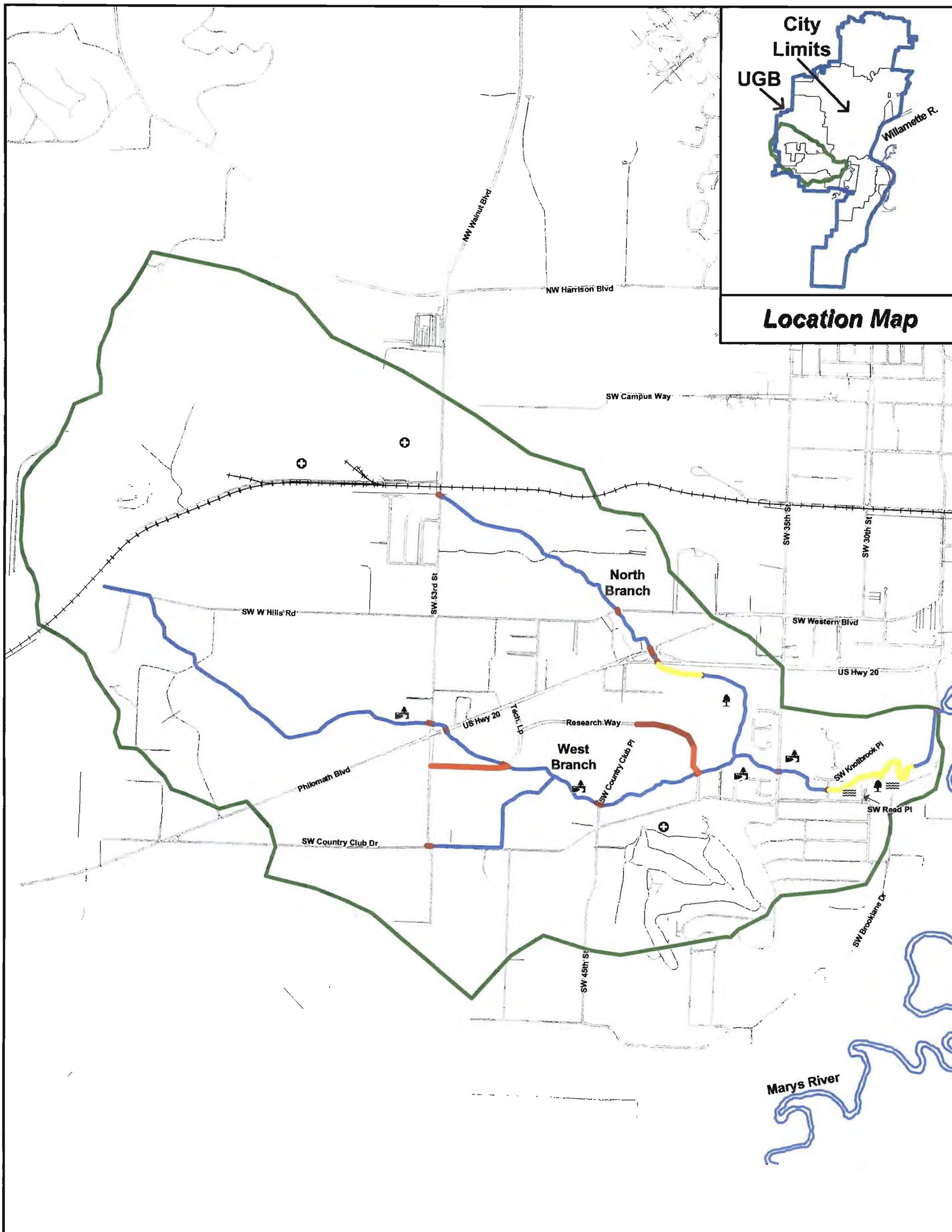


Figure 7-4 Long Term Project Locations

(see Table 7-5 for project descriptions)

LEGEND

Pipes/Bridges
Channels
Basin Boundary
Bank Stabilization
Canopy Revegetation
Channel Improvement
Replace Pipe/Bridge
Fish Passage
Buffer/Riparian Habitat
Floodplain Reconnection
Water Quality BMP
Flood BMP
Maintenance
Monitor
Multi-Use Facility

N

CORVALLIS
Public Works Department

BROWN AND CALDWELL
and Associated Firms

report/figures/final/fig7-4.wor, October 20, 2000, base data from City of Corvallis GIS Department

CHAPTER 8

WATERSHED PLANNING AND ANALYSIS: JACKSON/FRAZIER/VILLAGE GREEN CREEKS

8.1 INTRODUCTION

This watershed consists of the Jackson, Frazier, and Village Green Creeks, which form a complex network of streams and wetlands to the north of the Corvallis city limits. Jackson and Frazier Creeks both originate in McDonald State Forest. The headwaters of Jackson Creek are located near Dimple Hill. Frazier Creek originates farther north near the Lewisburg Saddle. The two creeks flow eastward through the state forest and into low-density residential developments prior to merging at Highway 99. East of Highway 99 their combined flow enters the Jackson-Frazier Wetland, an important habitat area. The flow leaving the wetland is split. Part of the flow heads northeast across farmland to connect with the Willamette River at Bowers Slough, downstream of Lower Kiger Island. The remaining flow runs south from the wetland as Village Green Creek. Village Green Creek turns to the southeast, flows through largely residential neighborhoods, and eventually joins Sequoia Creek to the east of Conser Street.

The Jackson Creek portion of the watershed contains over 1,500 acres, of which forest land is currently the largest land use with about 700 acres. Over 400 acres is currently undeveloped. In the future, the forest land will still be present, but the undeveloped land may be largely replaced by low-density residential development. The Frazier Creek drainage area is larger, with over 2,200 acres within its drainage boundary. Like the Jackson Creek area, the largest land uses are forest (1,000 acres) and undeveloped land (almost 600 acres). In the future, the undeveloped land may become part of almost 900 acres of new low-density residential. Two-thirds of the 380 acres draining to Village Green Creek are residential. The mix of low-, medium-, and high-density residential will remain the same in the future. The area designated as open space will increase slightly, from 28 percent at present to 33 percent in the future.

8.2 WATERSHED FINDINGS

Information on watershed conditions was obtained by collecting public comments at open houses, working with City staff to identify maintenance and operation problems, conducting a technical stream evaluation of selected reaches, and by modeling the conveyance system for the existing and build-out scenarios. This information was compiled by stream reach and is summarized in Section 8.2.5. A map of the Jackson/Frazier/Village Green Creeks watershed, presented as Figure 8-1, shows the location of the streams and identifies some of the major observations made during the watershed study.

Village Green Creek is typical of many urbanized streams. It is highly channelized and in many locations has little or no available shade. However, unlike many other Corvallis streams, Village Green Creek has few structures encroaching on its bank. The open stream banks, such as at Village Green Park (Figure 8-2, Photo 1), are potential sites for projects to enhance stream and riparian health. For instance, in many areas of this watershed the floodplain can be reconnected to the stream, thereby enhancing habitat as well as alleviating downstream flooding.

The Jackson-Frazier Wetland is a key component of this watershed. The wetland lies just downstream of Highway 99 and receives the combined flows of Jackson and Frazier Creeks. The natural drainage through the wetland has been modified over the years, affecting the flows through the system. A berm along the southern perimeter of the wetland is one of the more obvious signs of the modifications. At present, flows leave the wetland via a drainage ditch to the northeast and Village Green Creek to the south. A number of studies have been conducted on the wetland's vegetation and wildlife. Most of the studies have been coordinated through Oregon State University. However, only limited information exists on the hydraulics of the wetland. Additional information and analyses are needed to better determine how the wetland reacts to large storm flows. The wetland is part of Benton County's park system. It currently contains a raised boardwalk used for an interpretive trail.

Above the wetland, Jackson and Frazier Creeks flow through mainly agricultural lands with low-density residential development concentrated along the streams. In this area, many stream reaches are in relatively good shape, with a fair amount of canopy cover and few erosion problems, as shown in Figure 8-2, Photo 2, taken just upstream of the Jackson-Frazier Wetland. Other reaches have had more development, resulting in constrained channels and bank erosion (Figure 8-2, Photo 3). The large amount of undeveloped space presents opportunities for restoring and enhancing floodplain habitat in a number of locations, such as that shown in Figure 8-2, Photo 4. Other opportunities for floodplain improvements exist on the campus of Crescent Valley High School where six different bridges and box culverts cross the stream (Figure 8-2, Photo 5). Farther upstream, in the headwaters of Jackson Creek, coordination efforts with property owners adjacent to the stream will be the key to maximizing the habitat potential of the area (Figure 8-2, Photo 6).

8.2.1 Public Comments

Public input into the watershed planning process has been encouraged and facilitated through a number of public meetings held at Cheldelin Middle School. Residents were encouraged to share their knowledge of problem areas and to identify opportunities for improving the health of the Jackson/Frazier/Village Green watershed. Most of the comments heard at the meetings were general in nature. The comments are shown below, as they were recorded at the meeting (with explanatory language added in parentheses when needed):

- "City should require on-site impoundment to reduce the flooding."
- "Other communities and neighborhoods have 'adopt a stream' – would be cost effective and works in other cities – have to 'pass plans' by City first to make sure meets community objectives."
- "Has seen changes to downstream flows, etc. Over the past years – the flashiness of it (downstream of Corvallis) at Stewart Slough."
- "Master Plan should acknowledge and have an overview regarding fish and habitat in the basin.

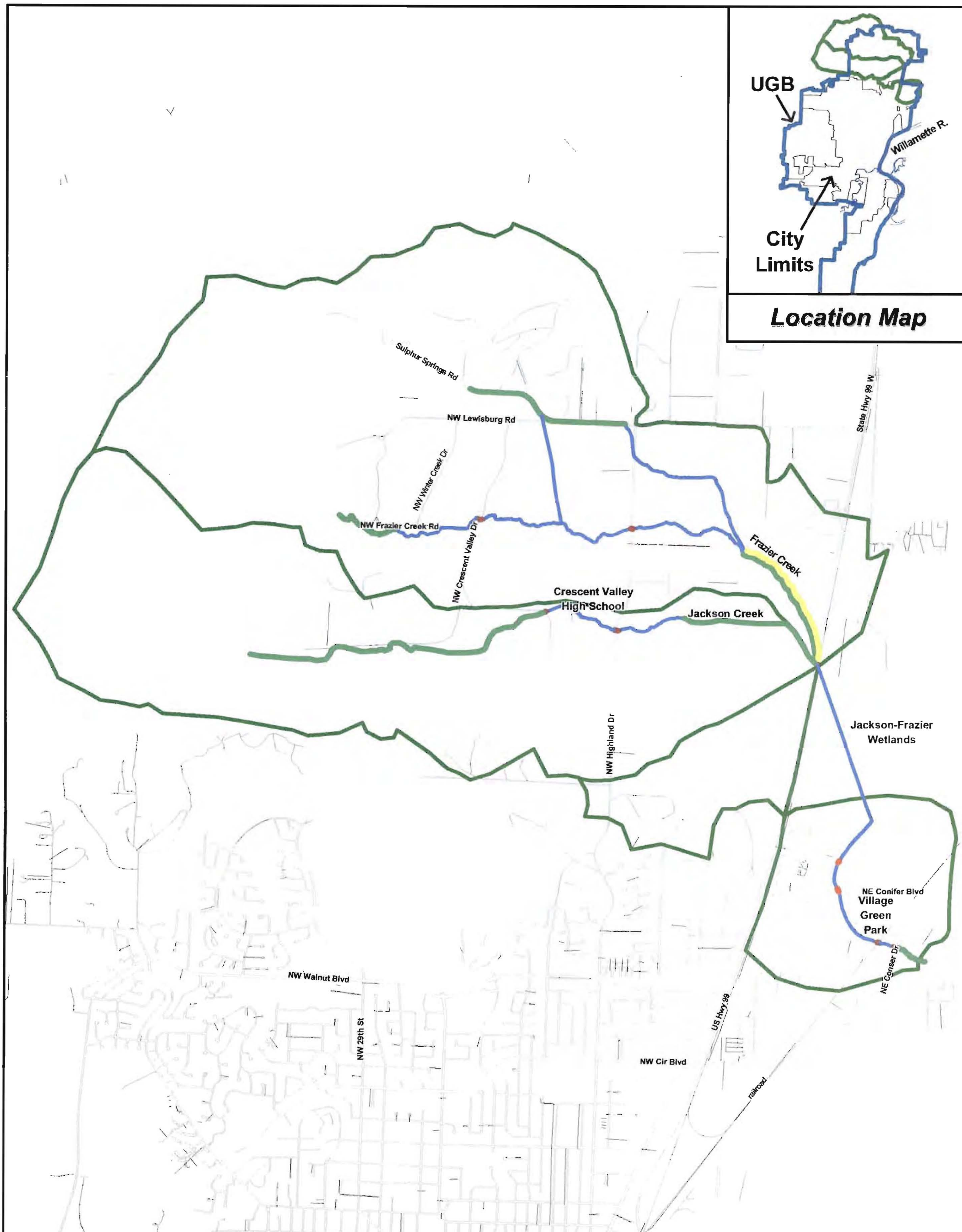


Figure 8-1 Jackson/Frazier and Village Green Problem Areas

LEGEND

- Pipes/Bridges
- Channels
- Basin Boundary
- Reported Problems (recorded at open house)
- Surcharged Manholes (10-year future storm)
- Flooded Manholes (10-year future storm)
- High Velocity Areas (> 4 fps, 2-year future storm)
- Undersized Conduits (10-year future storm)
- Undersized Channels (10-year future storm)

N

Feet 900 0 900 1800 2700 3600 Feet

CORVALLIS Public Works Department

BROWN AND CALDWELL and Associated Firms

report/figures/final/fig8-1.wor, October 27, 2000, base data from City of Corvallis GIS Department

Figure 8-2. Watershed Photos

Photo 1. Pedestrian bridge at Village Green Park

Photo 2. Jackson Creek upstream of Highway 99

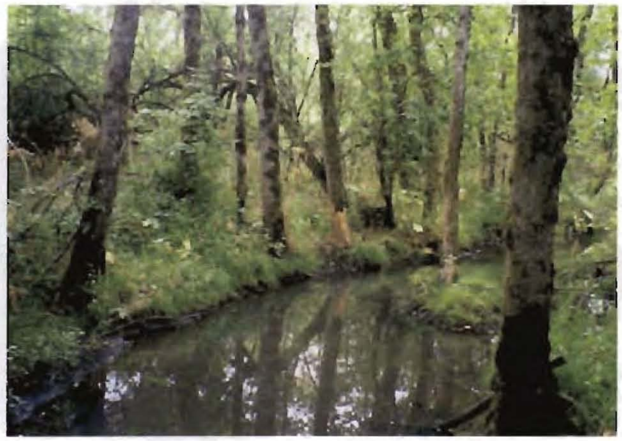


Photo 3. Jackson Creek downstream of Crescent Valley HS and Highland Drive

Photo 4. Jackson Creek at Highland Drive

Photo 5. Jackson Creek at courtyard area at CVHS

Photo 6. Jackson Creek headwaters structures

- "Where areas are logged first, then first fall storm there is an initial increase in flow (has been his experience) and higher turbidity in reaches – and this can take a while to recover. Need better best management practices to handle increases in flow and sediment. Not the case now, especially in county/urban areas. Aren't implementing land use practices that minimize flow changes and pollution problems."

- "Lives in Garryanna area - City plan includes UGB (Urban Growth Boundary) and need to coordinate better with County, including water quality issues for planning and enforcement – especially with Jackson-Frazier."

- "Problem is jurisdiction –Corps (Army Corps of Engineers) or DSL (Division of State Lands), County or City, State planning laws. First step – find out who has jurisdiction."

- "Is there any way after the SWMP (Stormwater Master Plan) is adopted to, along the way, at different times, check in to see how it is working out? Evaluate SWMP in the interim (at critical points). How is the plan held accountable?"

- "Should detention even out flows so that urbanization doesn't increase peaks and reduce low flows?"

Comments from the meetings regarding problem areas or specific enhancement opportunities are in Section 8.2.5.

8.2.2 City Staff Reports

City Engineering and Utilities Operations staff is familiar with portions of the Jackson/Frazier/ Village Green watershed through their day-to-day activities. Other sections of the watershed are outside of the City's jurisdiction. City staff provided input into the planning process by identifying known problem areas, recommending areas for stream enhancement activities, and recounting the extent and duration of flooding during major storm events. For example, the extent of flooding from the February 1996 storm was well documented. During that storm, road closures were reported in the Village Green portion of the watershed, along sections of Conifer Boulevard from Highway 99 east to Cheldelin Middle School. High water was also reported along Plymouth Circle and Lancaster Street.

8.2.3 Field Study Observations

Watershed Applications, a stream rehabilitation specialty firm, conducted a series of field investigations beginning in November 1997. Field personnel evaluated selected lengths of Village Green Creek during stream walks. Jackson and Frazier Creeks were not investigated by Watershed Applications. Instead, a limited field survey was taken by Brown and Caldwell in July 2000 to report on general conditions in the Jackson and Frazier Creek basins. Information from all of the field observations is in Section 8.2.5.

8.2.4 Modeling Results

A computer model for the Jackson/Frazier/Village Green watershed identified the hydraulic capacity and projected flows in the pipes, culverts, and channels of the conveyance system for existing and build-out scenarios. Existing conditions were modeled based on the level of development at the time of modeling, including the new culvert added at Conifer Boulevard in 1999. Build-out conditions were modeled based on the future full development of the watershed as identified in the City's Comprehensive Plan. A full range of storm events was modeled for the existing and future scenarios, including the 2-, 10-, 25-, and 100-year storm events. A complete summary of all modeled segments is in Appendix C.

Table 8-1 shows the hydraulic structures (pipes, culverts, bridge crossings, etc.) that are undersized for the City's 10-year design storm. Specifically, two stream crossings are undersized according to the model. This agrees with the public reporting of flooding along Lancaster Street at or near both of the crossings. The model also showed overflows out of the Frazier Creek base channel just below the junction with the Sulphur Springs branch. This coincides with a wetland designation for this section of the stream.

The hydrologic/hydraulic model also estimated velocities occurring in channel segments to determine areas at risk for channel or streambank erosion. Instream high velocity criteria are described in Chapter 3. In general, velocities in excess of 4 feet per second (fps) may cause erosion of the streambank or streambed. The velocities during the 2-year storm event—the storm size most responsible for determining the channel configuration—were compared to the 4 feet-per-second criteria.

Table 8-1. Modeled Flow for Undersized Hydraulic Structures within the Jackson/Frazier/Village Green Watershed, cubic feet per second

Reach/Location/Model segment	Full pipe or channel capacity[1]	10-year storm flows		Flooding predicted by model	Flooding reported by staff or public
		Existing	Future		
Conifer Boulevard to Jackson-Frazier Wetland/Conifer Boulevard	271	236	236	Yes	Yes
Conifer Boulevard to Jackson-Frazier Wetland/Oxford Circle	225	251	253	Yes	Yes
Highway 99 to Highland Drive (Frazier Creek)/ Downstream of Sulphur Springs Branch	404	427	429	Yes	No

[1] The full pipe or channel capacity is based on Manning's equation. It does not account for hydraulic effects from downstream backwater effects.

As Table 8-2 indicates, a number of the modeled stream reaches within the Jackson/Frazier/Village Green watershed exceed velocity criteria. The channels with high velocities are either located on steep slopes in the headwater areas or just upstream of Highway 99. Also, the table indicates if erosion of the channel or stream bank has been observed or if stream bank stabilization projects have been implemented. Several of the stream reaches did not undergo field inspection and therefore lack erosion observations.

Table 8-2. Modeled Velocities for Jackson/Frazier/Village Green Channel Segments Exceeding 4 Feet per Second

Reach/Model segment	2-year storm		Erosion observed	Existing bank stabilization
	Existing velocities	Future velocities		
Village Green Creek				
No excessive velocities in these reaches	--	--	--	--
Jackson Creek				
Jackson-Frazier Wetland to Highland Drive/3300 feet upstream of Highway 99	5.1	5.1	Yes	No
Crescent Valley Drive to McDonald State Forest/Jackson Creek Road to Crescent Valley Drive	4.4	4.4	Yes	No
Crescent Valley Drive to McDonald State Forest/Along Jackson Creek Road	9.0	9.0	Yes	No
Frazier Creek				
Highway 99 to Highland Drive/Highway 99 to Sulfur Springs tributary	5.5	5.5	No	No
Sulfur Springs Branch/Along Lewisburg Road	5.8	5.7	No	No
Sulfur Springs Branch/Along Sulfur Springs Road	5.3	5.3	No	Yes
Frazier Creek Headwaters/Along Frazier Creek Road	6.6	6.6	Yes	No

8.2.5 Stream Reach Summaries

For study purposes, Jackson, Frazier, and Village Green Creeks have been divided into a number of reaches based on the physical characteristics of the stream, property ownership, and any other unique characteristics that might distinguish one section of the stream from the rest. Public comments, City staff reports, field observations, and modeling results for each reach are summarized in the following sections. Problems described by the public are noted as they were recorded at public meetings. Parentheses are used to identify any clarifications.

Sequoia Confluence to Conifer Boulevard

Public Comments: "Stream is eroding toward his fence." (Village Green stretch near footbridge – upstream.)

"This isn't a stream, it's a manmade ditch."

"Concern of continued degradation of Village Green channel that will eventually destroy his property."

"Nutria is a problem – annual – burrow into banks that are already steep and when floods, the tunneled banks collapse."

"City took seven nutria from Village Green last summer (1998)."

"Does City inspect storm drains after larger events? Example, drainage entry just downstream of foot bridge was plugged for several weeks (grate at culvert). He has called City several times on problems and City came right away."

City Staff Reports: The channel downstream of Village Green is flat and prone to vegetation blockages. Over the last 5 years, City staff has responded to a variety of complaints about erosion, vegetation blockage, and flooding in the manmade channel section of Village Green Creek. An additional high-flow culvert was installed at Conifer Boulevard in 1999 to help reduce the potential for flooding. A detailed comprehensive analysis is required for the entire Jackson and Frazier basin that addresses peak flows, wetlands, floodplain, and stream corridor issues.

Field Observations: The channel downstream of Conser Street has a dense growth of trees. The trees provide a good canopy, but have a tendency to cause debris to collect. The large metal culvert under Conser Street has very shallow flows during summer, barely deeper than the corrugations. A large number of stormwater pipes discharge into the creek from Conser Street up to the railroad bridge. Vegetative buffers and canopy coverage are in generally poor condition along this section of channel. Above the railroad bridge, Village Green Park has a closely mowed lawn and few trees on the park side of the creek. The footbridge connecting the park with Sherwood Way to the south has a relatively small clearance space above the low-flow water surface. The overbank area of the park is a potential location for a facility to improve habitat and store larger flows. Upstream of the park the channel is more constricted. The banks are steep and some erosion is occurring. Plywood sheeting along the south bank of the bend appears to be a homemade attempt at bank stabilization. A couple of large stormwater pipes discharge to the creek on the south bank. Based on backyard fence placement, there appears to be some space along the south bank available for an enhancement project.

Modeling Results: The model showed no capacity problems with the reach's existing channel, culverts, and bridges. Velocities were not predicted to exceed the 4 feet-per-second criteria for erosion during the 2-year storm event.

Conifer Boulevard to Jackson-Frazier Wetland

Public Comments: No comments were received for this reach at the public meetings. However, during field investigations the consultant staff received comments from local residents who expressed concern about flooding of roadways. The residents were especially concerned with the flooding of the roads leading to the daycare center located on the east side of the stream at Oxford Circle.

City Staff Reports: This reach will flood during a 5-year storm event. An additional high-flow culvert recently installed at Conifer Boulevard helps reduce the flooding at this location. Following recent development in the area, heavy public use has impacted the revegetation of this reach.

Field Observations: In this reach, the creek flows through a highly constrained trapezoidal channel. No shrubs or trees provide shade. The vegetation on both banks is grass mowed almost to the water's edge. The land use immediately surrounding the channel is mostly apartments and townhomes with associated parking lots.

Modeling Results: Village Green and the culverts at Conifer Boulevard were modeled as part of the City's Flood Mitigation Program in 1998. Modeling at that time showed that the culverts are undersized and water is backing up onto Lancaster Street near Oxford Circle. This confirmed reports of flooding by City staff and the public. The City installed an overflow culvert at Conifer Boulevard in 1999 to help reduce flooding in the area.

Remodeling of Village Green with the new culvert showed that water still backs up behind the culverts at Conifer Boulevard, but with a reduced potential for flooding along Lancaster Street. In addition, the model showed high water levels likely at Oxford Circle and Lancaster Street due to the undersized culverts at Oxford Circle. Velocities along the channel did not exceed the 4 feet-per-second criteria for erosion.

Jackson-Frazier Wetland

Public Comments: "Jackson-Frazier wetlands are beautiful with lots of voluntary support and effort (provided by the public). (The wetland) Cleans (the) water then water comes out and mixes with other water coming in and gets degraded. All of that work should be protected and other volunteer work help other reaches."

City Staff Reports: A detailed comprehensive analysis is required for the entire Jackson and Frazier basin that addresses peak flows, wetlands, floodplain, and stream corridor issues. Hydraulics, aesthetics, and habitat values are not coordinated in a comprehensive plan. The northeast discharge from the wetlands is ditched through farmland to the Willamette River. The City may have future stormwater regulatory responsibility for flows into this ditch as the City expands within the northern portion of the UGB.

Field Observations: The Jackson-Frazier Wetland, which lies east of Highway 99, receives the flows from the now joined Jackson and Frazier Creeks. During lower flows, most of the water follows a small, apparently manmade channel that leads south to form Village Green Creek. The remainder of the flow enters a drainage ditch, leading across farm fields to the northeast. During high flows, the water spreads out in a broad sheet across the wetland before leaving the wetland to the south or northeast.

Modeling Results: No capacity or velocity problems were noted. Further work is needed to confirm the hydraulics of the wetland, such as the elevations at which overflows occur, the proportion of flows leaving via the northeast drainage ditch, and the influence of groundwater. The wetland covers approximately 200 acres; consequently, the wetland has a large impact on the hydraulics of the downstream conveyance system. A detailed topographic survey of the entire wetland area and flow monitoring information would be required to accurately model the response of the wetland and discharging streams to storm events.

Jackson-Frazier Wetland to Highland Drive (Jackson Creek)

Public Comments: No public comments on this reach.

City Staff Reports: Property owners have reported to the City that changes from past flooding patterns have occurred as a result of channel meandering during the past five years of high rainfall events. Privately owned creek crossings in this reach have not been permitted by the Oregon Division of State Lands or the Oregon Department of Fish and Wildlife. A private low-elevation dam was reported, but has not been located. Irrigation uses and their impacts on stream flows are not clearly documented or understood.

Field Observations: The combined creeks downstream of Highway 99 create a quiescent pool under the railroad trestle. Upstream of Highway 99, Jackson Creek has a good canopy cover with a large proportion of willows. An approximate 50-foot buffer runs along the main channel, with narrower buffers along tributary ditches and channels. Blackberry thickets are present along the edge of the buffer. Jackson Creek is quiescent immediately upstream of Highway 99 with no apparent channel incision. The surrounding land use is hay fields. At the upstream end of this reach, Jackson Creek flows through a corrugated metal culvert under Highland Drive and then down a slight drop over rocks. The culvert is clean with no noticeable debris or sediment deposits. The channel is in poor condition downstream of the culvert with downcutting, bottom scouring, and a number of woody debris dams. Ivy covers much of the bank under the trees with blackberry brambles between the stream and the hay fields to the north and south of the channel. The narrow vegetative buffer shows evidence of heavy use by deer. The hay field to the south of the main channel is small and sandwiched between the main channel and a tributary ditch. This area may be a potential candidate for habitat enhancement or a detention pond project; however, part of the meadow to the south of the ditch is lower in elevation and may be a better location for a pond or wetland.

Modeling Results: The model showed that the reach has no capacity problems. Velocities exceeded the 4 feet-per-second criteria for erosion in the lower section of the reach. Modeled velocities in the upper section (near Highland Drive) did not exceed criteria, but the lack of surveyed cross-sections prevented good definition of the low-flow channel, possibly resulting in underestimated velocities.

Crescent Valley High School, Highland Drive to Crescent Valley Drive (Jackson Creek)

Public Comments: No public comments on this reach.

City Staff Reports: School facilities need to be upgraded to provide water quality protection from stormwater runoff from parking lots and other paved areas. During power failures, reported spills have occurred from the wastewater system pressure pump station at the school into a ditch leading to Jackson Creek. Under the existing emergency response plan, a temporary power generator placed at the pump runs the station until power is restored. The City plans to install a permanent backup generator in 2003.

Field Observations: Immediately upstream of Highland Drive, a 12-inch water pipe crosses Jackson Creek at the water's surface. The channel is somewhat downcut, but has a good canopy until reaching the Crescent Valley High School (CVHS) buildings. The CVHS campus has six separate stream crossings, including a concrete box culvert under the concrete apron of the main courtyard area, concrete footbridges upstream and downstream of the courtyard, a ramp leading across the stream to what appears to be a second floor garage, and two wooden footbridges upstream of the campus buildings that connect the sports fields. The box culvert under the courtyard appears to be the most restrictive to stream flows. Although the stream has a natural bottom through most of the campus, it is heavily incised in places and has been armored with riprap.

Modeling Results: The model showed that the natural channel and the roadway culverts in this reach can accommodate 10-year storm events. Velocities were below the 4 feet-per-second criteria for erosion. Physical information on the hydraulic structures at CVHS was not available and thus these structures were not included in the modeling effort. A field survey of these structures would be required to obtain the detailed physical information required for modeling.

Crescent Valley Drive to McDonald State Forest (Jackson Creek)

Public Comments: "How about help if we are outside the City and our property is flooding. She (the speaker) has water at back door and when she was out of country their land was declared a wetland. She is upstream of Crescent Valley High School and has had Jackson Creek rushing 3 feet deep across their property. There has also been deposition of sediment – lots of silt coming from upstream and the channel is moving. The creek has made a new creek bed. Feels that County improvements at the bridge have contributed to the flooding problem."

City Staff Reports: Property owners have reported erosion and deposition problems that have changed the flood response of the creek in this area. Several owners feel that management of forest lands owned by Oregon State University has resulted in an increase in peak runoff that has caused incision of the stream and erosion problems. There is no established buffer between the creek and agricultural activities in this reach.

Field Observations: The stream gradient becomes markedly steeper upstream of Crescent Valley Drive. The drainage is from mostly agricultural or undeveloped land, except along the creek. Single-family homes on large lots are sited next to the creek. The homes have numerous frontage culverts and bridges, mostly to accommodate driveways over the creek. A few of the homes have footbridges. The creek flows through a series of manmade ponds and waterfalls at one residence. The canopy coverage is generally good in this reach, except where the large transmission lines cross the creek.

Modeling Results: The model showed that the reach has no capacity problems for the 10-year storm event. Velocities for this reach are predicted to exceed the 4 feet-per-second criteria for erosion due to the steep channel gradient.

Jackson Creek Headwaters (McDonald State Forest)

Public Comments: No public comments on this reach.

City Staff Reports: No input was received from City staff on this reach.

Field Observations: No observations made.

Modeling Results: Runoff from this reach was included in the overall hydrologic model, but this reach was not specifically included in the hydraulic model.

Highway 99 to Highland Drive (Frazier Creek)

Public Comments: No public comments on this reach.

City Staff Reports: This reach has no established buffer between the creek and agricultural activities.

Field Observations: Frazier Creek joins Jackson Creek from the north at Highway 99. Most of the tributaries to Frazier Creek appear to be agricultural ditches with little vegetative cover. The buffer width and canopy coverage for Frazier Creek decrease upstream near Harman Drive. A number of houses with large yards are located on the south side of the creek. The Crescent Valley Evangelical Church at the corner of Harman Lane and Highland Drive has a large gravel parking lot with runoff passing across a grassy strip before reaching the creek.

Modeling Results: Where the Sulfur Springs Branch joins the main stem of Frazier Creek, channel capacity is undersized for the 10-year storm event. Velocities downstream of this point exceeded the 4 feet-per-second criteria for erosion.

Highland Drive to Crescent Valley Drive (Frazier Creek)

Public Comments: No public comments on this reach.

City Staff Reports: This reach has no established buffer between the creek and agricultural activities.

Field Observations: The main land use in this reach is agricultural. The buffer width is limited throughout the reach. At the upstream end near Crescent Valley Drive, the hayfields and pasture extend essentially to the streambank. Little channel incision was observed.

Modeling Results: Modeling showed that the reach has no culvert or capacity problems for the 10-year storm event. Velocities in the reach did not exceed the 4 feet-per-second erosion criteria.

Frazier Creek Headwaters (Upstream of Crescent Valley Drive)

Public Comments: No public comments on this reach.

City Staff Reports: No specific input was received from City staff on this reach.

Field Observations: Good canopy coverage exists at Crescent Valley Drive, but the understory is a large expanse of blackberry brambles. The creek angles sharply to flow through a corrugated metal culvert under Frazier Creek Road. Vegetative buffers and canopy cover are lacking upstream of this crossing and the stream banks are mostly exposed soils with signs of erosion. The vegetation along the Frazier Creek branch that flows underneath Winter Creek Road alternates between landscaping down to its banks or blackberry brambles. The creek in this area doesn't appear to be experiencing downcutting problems.

Modeling Results: Modeling showed that the reach has no capacity problems for the 10-year storm event. The modeling indicated that velocities exceeded the 4 feet-per-second criteria for erosion at the upstream end of this reach.

Sulfur Springs Branch (Frazier Creek)

Public Comments: No public comments on this reach.

City Staff Reports: No input was received from City staff on this reach.

Field Observations: Topographic analysis based on U.S. Geological Survey topographic maps and the City's GIS coverage show the main drainage runs east of Sulfur Springs Road and then crosses under Lewisburg Road near Highland Drive. During fieldwork, a ditch to the west of Sulfur Springs Road was observed. This ditch is a steep, riprapped channel containing several concrete check dams. It crosses under Lewisburg Road close to Crescent Valley Drive. Downstream of the crossing, trees line a small channel leading southward. The channel was dry at the time of the observation.

Modeling Results: Modeling showed that the reach has no capacity problems for the 10-year storm event. Velocities exceeded the 4 feet-per-second criteria for erosion along Lewisburg and Sulfur Springs Roads due to the steep slope of these stream segments.

8.2.6 Watershed Summary

Stream conditions along the Jackson/Frazier/Village Green Creeks reflect the variety of land uses through which the creeks pass. At the downstream end of the watershed, Village Green Creek is highly channelized and lacks good vegetative cover at many locations as it flows through low- to high-density residential areas. Upstream of the developed urban area, the Jackson-Frazier Wetland provides good habitat with little or no erosion and channel downcutting. The hydraulics of the Jackson-Frazier Wetland are not well understood. This area could be modeled given a detailed topographic survey of the area and flow monitoring of the input and exit flows.

Upstream of Highway 99, agricultural land use predominates, with the stream buffer ranging from good to nonexistent. Some erosion of the channel was observed, particularly in the steep, upper reaches where much of the land along the stream has been developed as single-family residences. Although the canopy cover is good in many of the residential areas, landscaping down to the streambank is also common, with a resultant loss of habitat. The headwater reaches within McDonald State Forest were not investigated. Although the headwater areas are not likely to be developed, the impact of forestry practices on the overall health of the stream needs to be considered.

8.3 WATERSHED MANAGEMENT OPTIONS

Recommendations for the Jackson/Frazier/Village Green Creeks watershed are shown in Table 8-3. The short-term options identified in Table 8-4 focus on involving the community in activities to protect or enhance the streams and riparian areas. Vegetation management is recommended at various locations to either remove non-native invasive species or to enhance the riparian canopy. Educational activities are recommended to inform the public about water quality and habitat issues and to explain how their activities may impact the health of the streams. In addition, the short-term options include the development of conservation easements along the streams in order to widen and protect vegetative buffers and to provide City access to the stream.

The long-term options shown in Table 8-5 include several capital improvement projects to enhance the channel and provide for greater flood protection by reconnecting the channel with the floodplain and existing wetlands. Other recommended options include increasing the buffer widths and providing better canopy coverage. These actions will help filter pollutants out of the runoff before it enters the stream, keep the stream cooler, and provide increased habitat value. The last type of recommended solution requires structural work at locations where culverts or other structures are poorly aligned or present a barrier to fish passage.

Several elements of both the short-term and long-term programs are intended to decrease downstream flooding through preservation of natural wetland and floodplain areas. Flooding along Village Green, especially along Lancaster Street, has been a longtime concern of the City. Information gathered during a flood mitigation study in 1999 was incorporated into the current work. In 1999, an additional culvert at Conifer Boulevard was added that reduces flood water levels along Lancaster Street. However, high water still persists at the corner of Oxford Circle and Lancaster Street due to the undersized culverts at Oxford Circle.

Options for alleviating the flooding along Lancaster Street are limited. Replacing the bridges at Conifer Boulevard and Oxford Circle would eliminate the flooding in this area, but could increase the flooding downstream of Conifer Boulevard, particularly during larger storm events that are coupled with high water levels in Stewart Slough. Increasing the size of the channel directly upstream of Conifer Boulevard provides very limited improvement. A 24-acre-foot detention facility located upstream of Highway 99 would reduce flows by approximately 100 cfs and would reduce the potential for flooding along Lancaster Street. However, the construction cost for the facility is estimated at nearly $500,000. A detention facility's impacts on the groundwater hydrology and hydraulics of the Jackson-Frazier Wetland would have to be evaluated. The proposed location of a detention facility is a designated wetland area that would present construction-permitting challenges. Expanding the detention capabilities of the Jackson-Frazier Wetland and re-establishing the discharge point from the northeast corner of the wetlands appear to have the greatest potential for removing the persistent Village Green Creek flooding.

A number of studies and planning efforts are currently underway for the Jackson-Frazier Wetland. The wetland is part of the Benton County park system. The Jackson-Frazier Wetland Advisory Committee, which is appointed by the Benton County Board of Commissioners, is expecting a revised master plan for the County park containing the wetland. An Oregon State University engineering class is conducting a hydrologic study of the wetland. The study includes monitoring of inflows and outflows to determine the water balance of the wetland. The City is also removing portions of the earthen berm that separate the wetland from several formerly connected wetland acres to the southwest.

Coordination with the ongoing studies and planning efforts is required to better define the hydrology and hydraulics of the Jackson-Frazier Wetland. The outcome of these studies will help determine whether additional storage or diversion is available as a valid alternative for reducing the potential for flooding along Lancaster Street.

Table 8-3. Jackson/Frazier/Village Green Options

Reach	Abridged observations	Recommended activity	Priority
Sequoia Confluence to Conifer Boulevard	1) Lack of habitat and constricted channel.	a. Reconnect floodplain and provide for stream meander at Village Green Park and plant native vegetation.	Long-term
		b. Plant trees at top of bank for shade.	Short-term
	2) Constricted channel upstream of park.	a. Widen channel upstream of park where space permits.	Long-term
	3) Opportunity for water quality or detention facility at Village Green Park.	a. Begin talks with Parks Department about concept. Conduct detailed survey work to determine potential volume of treatment.	Long-term
	4) Flat channel downstream of Village Green is prone to vegetation blockages.	a. As part of a comprehensive analysis of stream corridor issues, including Jackson-Frazier Wetland hydraulics, determine extent of flooding and ways to deal with source of blockages.	Short-term
Conifer Boulevard to Jackson-Frazier Wetland	1) Local concerns about flooding during large storms.	a. Address with storage/diversion at Jackson-Frazier Wetland. (See appropriate reach below).	Long-term
	2) Lack of shade along stream.	a. Plant trees/shrubs as part of community involvement program. Use dense or thorny shrubs or other ground cover to limit heavy foot traffic in eroded areas.	Short-term
Jackson-Frazier Wetland	1) The hydrologic response of the wetlands is poorly understood. City may have future responsibility for stormwater flows through ditch to the northeast.	a. Coordinate with County and Oregon State University studies to determine flow regime and storage potential of wetland, especially flow split between Village Green and drainage ditch to northeast. Coordinate with Jackson-Frazier Friends group.	Short-term

Table 8-3. Jackson/Frazier/Village Green Options (continued)

Reach	Abridged observations	Recommended activity	Priority
Jackson-Frazier Wetland to Highland Drive (Jackson Creek)	1) Limited buffer width along some sections of the stream.	a. Work with agricultural interests to increase vegetative buffer width along stream.	Long-term
		b. Establish conservation easements with willing property owners.	Short-term
	2) Channel erosion, concrete debris, and invasive vegetation adversely impact channel downstream of Highland Drive.	a. Remove non-native vegetation, widen streambanks and stabilize with willow plantings. Work in conjunction with #4, below.	Short-term
	3) Potential wetland restoration opportunity downstream of Highland Drive and Crescent Valley High School.	a. Investigate property ownership and willingness of owner to sell wet meadow. Work in conjunction with #1, above.	Long-term
	4) Unpermitted private creek crossings and reported dam.	a. Provide information to property owners about permitting requirements.	Ongoing
Crescent Valley High School (Highland Drive to Crescent Valley Drive-Jackson Creek)	1) PVC pipe crossing creek (16-inch water main).	a. Re-route pipe along roadway.	Short-term
	2) Channel erosion and invasive vegetation through Crescent Valley High School grounds.	a. Community stewardship opportunity to work with school to remove non-native invasive species like blackberry and ivy.	Short-term
	3) Potential capacity problems with Crescent Valley High School bridges and culverts.	a. Call problem to school district's attention.	Short-term
		b. Widen channel upstream of school and provide for stream meander.	Long-term
	4) Pollution potential from Crescent Valley High School parking lots and athletic fields runoff. Spills reported from wastewater pump station at school into creek.	a. Coordinate with school district to install end-of-pipe treatment before discharge to stream from parking lots. Cut back pipe to allow vegetative treatment for playing field underdrains. Follow up on City plans for backup generator in 2003.	Short-term

Table 8-3. Jackson/Frazier/Village Green Options (continued)

Reach	Abridged observations	Recommended activity	Priority
Crescent Valley Drive to McDonald State Forest (Jackson Creek)	1) Excessive velocities indicate risk of erosion.	a. Anchor large, woody debris to slow flows and provide more varied habitat.	Long-term
		b. Develop conservation easements and stewardship programs in conjunction with property owners and County.	Short-term
	2) Flooding reported upstream of Crescent Valley High School.	a. Work with County to confirm hydraulic analysis of replacement bridge at Crescent Valley Drive.	Short-term
	3) Residences with landscaping to edge of stream and constructed dams, waterfalls, and stream crossings impinging on creek.	a. Educational efforts with residents to avoid water quality and fish passage problems.	Ongoing
Jackson Creek Headwaters (McDonald State Forest)	1) Logging practices and road construction in McDonald State Forest affect peak flows and erosion downstream.	a. Coordinate with Oregon State University Forestry Department and other property owners.	Short-term
Highway 99 to Highland Drive (Frazier Creek)	1) Many Frazier Creek tributaries are agricultural ditches with little or no trees for shading.	a. Increase buffer width and plant trees for shade along ditches.	Long-term
		b. Develop conservation easements and stewardship programs in conjunction with property owners and County.	Short-term
	2) Creek velocities may contribute to erosion.	a. Plant vegetation, such as willows or alders, to stabilize trouble spots.	Short-term

Table 8-3. Jackson/Frazier/Village Green Options (continued)

Reach	Abridged observations	Recommended activity	Priority
Highland Drive to Crescent Valley Drive (Frazier Creek)	1) Vegetative buffer width limited throughout this reach.	a. Increase buffer width and plant trees for shade along ditches.	Long-term
		b. Develop conservation easements and stewardship programs in conjunction with property owners and County.	Short-term
	2) Modeling predicts flooding of Highland Drive stream crossing from backwater during 10-year storm.	a. Reconnect stream with floodplain and provide for stream meander upstream of Highland Drive, allowing for more storage.	Short-term
Frazier Creek Headwaters	1) Angled culvert under Frazier Creek Road may cause capacity, erosion problems.	a. Coordinate with County to confirm history of flooding with local residents. If flooding is not an issue, armor culvert entrance and exit to minimize erosion. If flooding is an issue, use longer culvert to straighten flow path.	Long-term
	2) High velocities contributing to erosion problems observed in field.	a. Stabilize streambanks through vegetative plantings.	Short-term
	3) Poor habitat, either blackberries or residential lawns.	a. Replace invasive species with native species.	Long-term
		b. Develop conservation easements and stewardship programs in conjunction with property owners and County.	Short-term
Sulphur Springs Branch (Frazier Creek)	1) County has responded to the high velocities with a riprapped channel and concrete check dams.	a. Coordinate with County to inspect regularly for signs of erosion.	Short-term

Table 8-4. Jackson/Frazier/Village Green Creeks Short-Term Program

Reach	Recommended activity	Capital cost ($)	Annual O&M ($)	Project type[1]
Sequoia Confluence to Conifer Boulevard	1) Plant trees at top of bank for shade.	22,000	NA	Green line
	2) As part of a comprehensive analysis of stream corridor issues, including Jackson-Frazier Wetland hydraulics, determine extent of flooding and ways to deal with source of blockages.	30,000	NA	
Conifer Boulevard to Jackson-Frazier Wetland	1) Plant trees/shrubs as part of community involvement program. Use dense or thorny shrubs or other ground cover to limit heavy foot traffic in eroded areas.	2,100	100	Green line
Jackson-Frazier Wetland	1) Coordinate with County and OSU studies to determine storage potential and flow regime of wetland, especially flow split between Village Green and drainage ditch to northeast. Coordinate with Jackson-Frazier Friends group.	19,200	NA	
Jackson-Frazier Wetland to Highland Drive (Jackson Creek)	1) Establish conservation easements with willing property owners.	4,000	NA	
	2) Remove non-native vegetation, widen stream and stabilize with willow plantings. Work in conjunction with long-term projects.	60,000	3,000	
Crescent Valley High School (Highland Drive to Crescent Valley Drive-Jackson Creek)	1) Reroute water pipe along roadway.	28,000	NA	
	2) Community stewardship opportunity to work with school to remove non-native invasive species like blackberry and ivy.	400	NA	
	3) Call potential flooding problem to school's attention.	200	NA	
	4) Coordinate with school district to install end-of-pipe treatment before discharge to stream from parking lots and cut back pipe to allow vegetative treatment for playing field underdrains.	800	NA	
Crescent Valley Drive to McDonald State Forest (Jackson Creek)	1) Develop conservation easements/ stewardship programs in conjunction with property owners and County.	4,000	NA	
	2) Work with County to confirm hydraulic analysis of the replacement bridge at Crescent Valley Drive.	800	NA	

Table 8-4. Jackson/Frazier/Village Green Creeks Short-Term Program (continued)

Reach	Recommended activity	Capital cost ($)	Annual O&M ($)	Project type[1]
Jackson Creek Headwaters (McDonald State Forest)	1) Coordinate with Oregon State University Forestry Department and other property owners.	800	NA	
Highway 99 to Highland Drive (Frazier Creek)	1) Develop conservation easements/stewardship programs in conjunction with property owners and County.	4,000	NA	
	2) Plant vegetation, such as willows or alders to stabilize trouble spots.	6,000	300	Green line
Highland Drive to Crescent Valley Drive (Frazier Creek)	1) Develop conservation easements/ stewardship programs in conjunction with property owners and County.	4,000	NA	
	2) Coordinate with County to reconnect stream with floodplain and provide for stream meander upstream of Highland Drive, allowing more storage.	800	NA	
Frazier Creek Headwaters	1) Stabilize streambanks through vegetative plantings.	800	NA	Orange line
	2) Develop conservation easements/ stewardship programs in conjunction with property owners and County.	4,000	NA	
Sulphur Springs Branch (Frazier Creek)	1) Coordinate with County to inspect regularly for signs of erosion.	NA	400	
Total		**191,900**	**3,800**	

[1]Project types are in the Figure 8-3 map legend.

Table 8-5. Jackson/Frazier/Village Green Creeks Long-Term Program

Reach	Recommended activity	Capital cost ($)	Annual O&M ($)	Project type[1]
Sequoia Confluence to Conifer Boulevard	1) Reconnect floodplain and provide for stream meander at Village Green Park and planting trees	100,000	5,000	
	2) Widen channel upstream of park where space permits	60,000	3,000	
	3) Begin talks with Parks Department on concept of detention at Village Green Park. Conduct detailed survey work to determine potential volume of treatment.	1,400	NA	
Jackson-Frazier Wetland to Highland Drive (Jackson Creek)	1) Work with agricultural interests and local conservation district to increase vegetative buffer width along stream.	2,000	NA	
	2) Investigate property ownership and willingness of owner to sell wet meadow. Work in conjunction with short-term projects.	4,000	NA	
Crescent Valley School (Highland Drive to Crescent Valley Drive-Jackson Creek)	3) Coordinate with County to widen channel and provide for stream meander upstream of school.	2,000	NA	
Crescent Valley Drive to McDonald State Forest (Jackson Creek)	1) Anchor large, woody debris to slow flows and provide more varied habitat.	20,000	1000	
Highway 99 to Highland Drive (Frazier Creek)	1) Increase buffer width and plant trees for shade along ditches.	12,000	NA	Green line
Highland Drive to Crescent Valley Drive (Frazier Creek)	1) Increase buffer width and plant trees for shade along ditches.	4,000	NA	Green line
Frazier Creek Headwaters	1) Coordinate with County to confirm history of flooding with local residents. If flooding is not big issue, armor culvert entrance and exit to minimize erosion. If flooding is issue, use longer culvert to straighten flowpath.	1,400	NA	
	2) Coordinate with County and landowners to replace invasive species with native species.	1,400	NA	
Total		**208,200**	**9,000**	

[1]Project types are in the Figure 8-4 map legend.

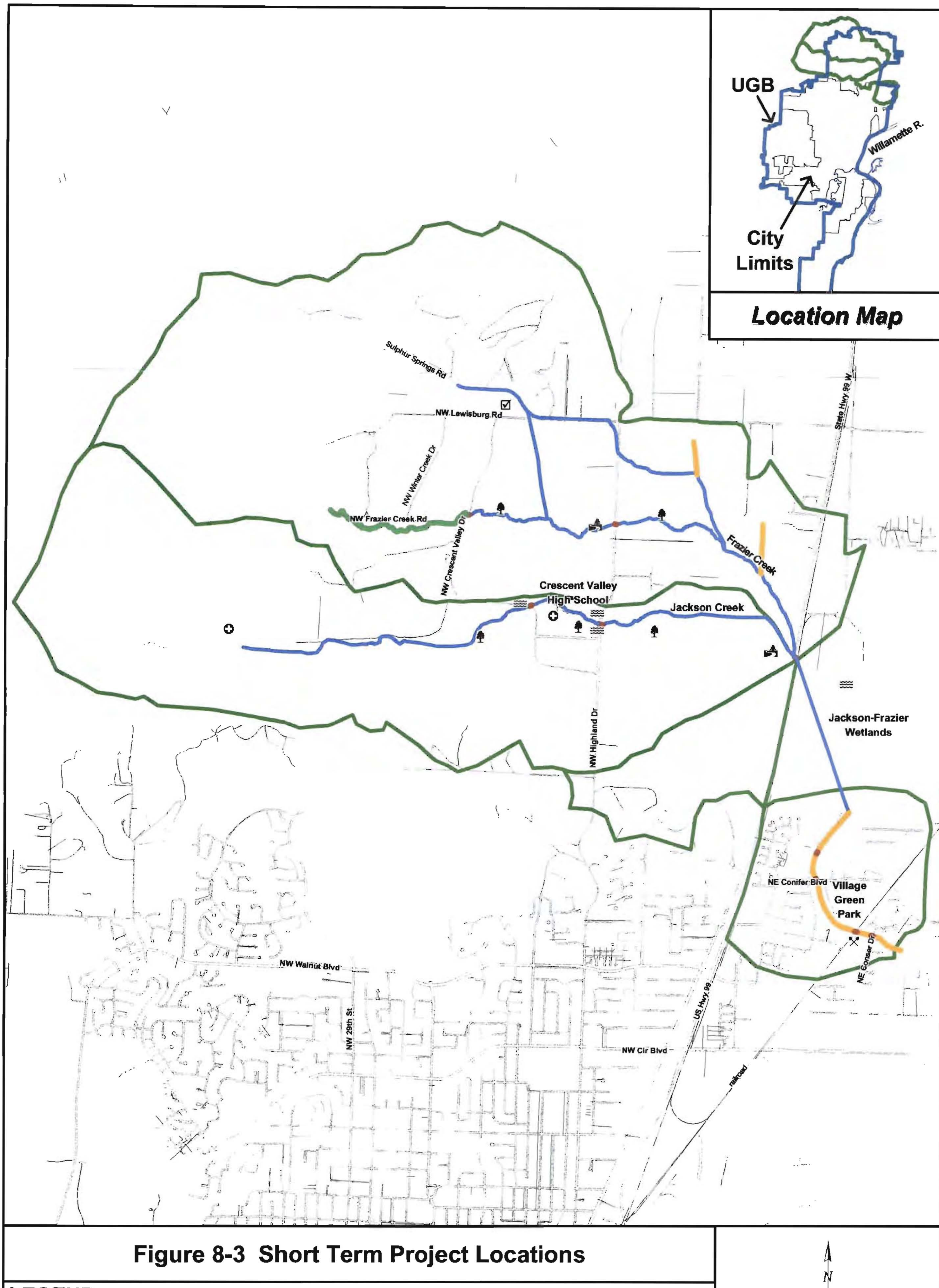


Figure 8-3 Short Term Project Locations

LEGEND

Pipes/Bridges	Channels	Basin Boundary
Bank Stabilization	Canopy Revegetation	Channel Improvement
Replace Pipe/Bridge	Fish Passage	Buffer/Riparian Habitat
Floodplain Reconnection	Water Quality BMP	Flood BMP
Maintenance	Monitor	Multi-Use Facility

N

CORVALLIS
Public Works Department

BROWN AND CALDWELL
and Associated Firms

report/figures/final/Fig8-3.wor, October 27, 2000, base data from City of Corvallis GIS Department

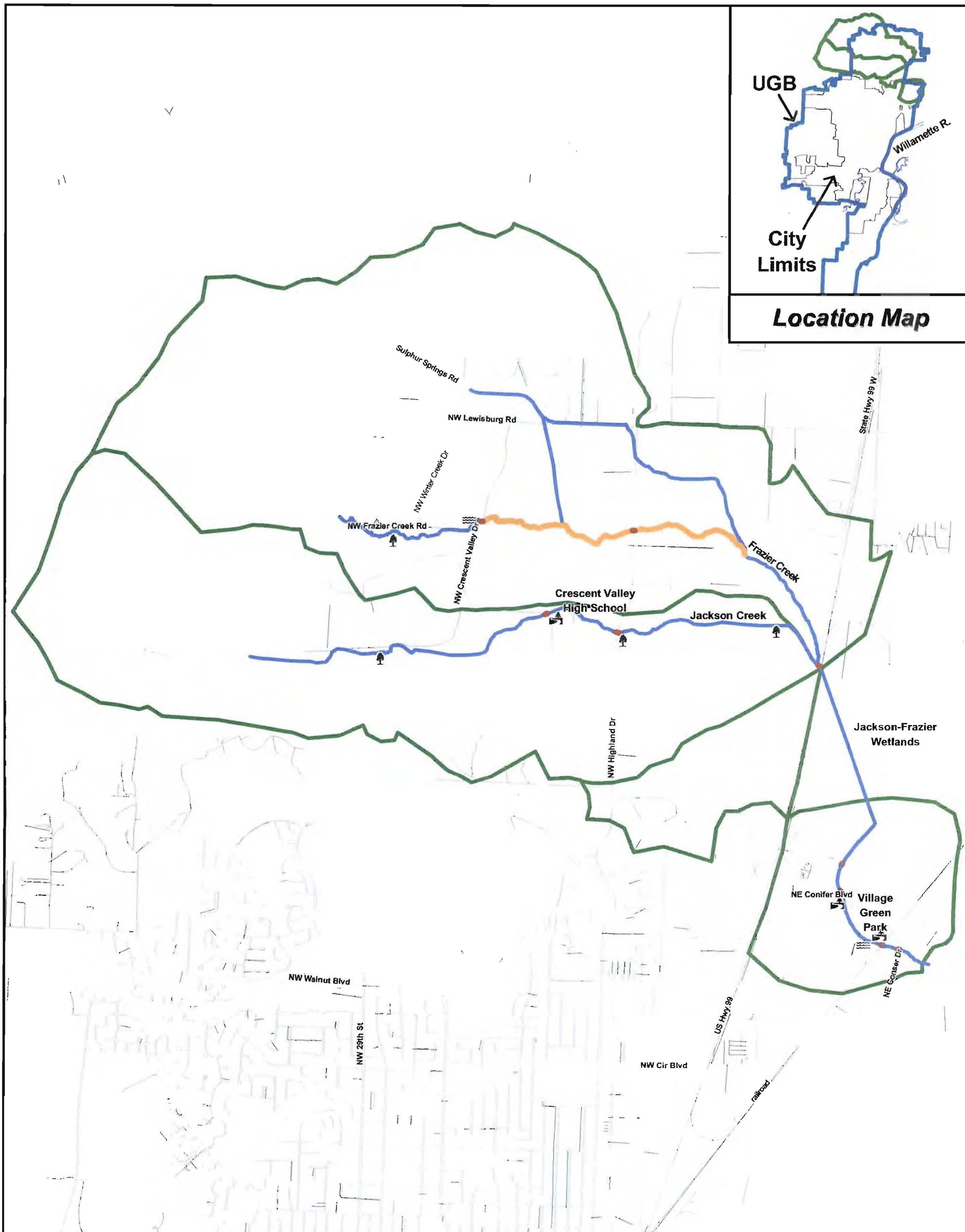


Figure 8-4 Long Term Project Locations

LEGEND

Pipes/Bridges
Channels
Basin Boundary
Bank Stabilization
Canopy Revegetation
Channel Improvement
Replace Pipe/Bridge
Fish Passage
Buffer/Riparian Habitat
Floodplain Reconnection
Water Quality BMP
Flood BMP
Maintenance
Monitor
Multi-Use Facility

N

Feet 900 0 900 1800 2700 3600 Feet

CORVALLIS
Public Works Department

BROWN AND CALDWELL
and Associated Firms

report/figures/final/Fig8-4.wor, October 27, 2000, base data from City of Corvallis GIS Department

CHAPTER 9

WATERSHED PLANNING AND ANALYSIS: SEQUOIA CREEK

9.1 INTRODUCTION

The Sequoia Creek headwaters originate near Chip Ross Park. The creek runs generally southeast through residential development, then turns eastward near Sycamore Avenue. The creek crosses beneath Highway 99W and the Willamette and Pacific Railroad trestle before turning to the northwest at its junction with Village Green Creek. After being joined by Village Green Creek, Sequoia Creek turns eastward, where it is known as Stewart Slough. The creek crosses beneath Highway 20 and ultimately discharges into the Willamette River.

The Sequoia Creek watershed contains 1,357 acres. The largest land use at present is low-density residential, which covers approximately 34 percent of the watershed. Fourteen percent of current use is medium- and high-density residential. City streets and rights-of-way take up approximately 14 percent of the available area. Approximately 12 percent of the land use is industrial, primarily located downstream of Highway 99W. Open spaces make up about 11 percent of the watershed. Land use in the remaining areas of the watershed includes a mixture of commercial properties, Oregon State University, and vacant land.

As future development occurs, the vacant land may be converted into low-, medium- and high-density residential areas. Other changes may include a decrease in industrial land use and an increase in commercial use. The number of acres of impervious land will increase from 543 acres to 650 acres, thus affecting the quantity and quality of stormwater runoff in the watershed.

9.2 WATERSHED FINDINGS

Information on watershed conditions was obtained by collecting public comments at open houses, working with City staff to identify maintenance and operation problems, conducting a technical stream evaluation of selected reaches, and by modeling the conveyance system for the existing and build-out scenarios. This information was compiled by stream reach and is summarized in Section 9.2.5. Figure 9-1, a map of the Sequoia Creek watershed, shows the location of the stream within the City and identifies some of the major observations made during the watershed study.

The elevation of the channel drops quickly relative to the horizontal distance, thus defining a steep gradient upstream of Walnut Boulevard. The gradient flattens out below that point, creating the potential for flooding in the transitional area between the hills and the flat area near the terminus of the creek. The gradient is flat downstream of 9th Street, thereby increasing the potential for flooding during large storm events.

Riparian conditions vary along the length of the stream. The riparian areas along Sequoia Creek are more natural (i.e., less degraded) toward the downstream end, as illustrated by Figure 9-2, Photo 1. This differs from other Corvallis streams, which are generally more degraded toward their downstream ends. Figure 9-2, Photo 2, illustrates how industrial land use encroaches on the creek near

Jack London Street. Also, a large number of debris dams in the creek downstream of Jack London Street obstruct flows, as shown in Figure 9-2, Photo 3. The recycling facility located along the north bank of the creek downstream of Highway 99W, as shown in Figure 9-2, Photo 4, is an example of industrial land use encroaching on the stream. Figure 9-2, Photo 5, shows sediment accumulation that may restrict higher flows at the culverts under 9th Street. The landscaped conditions typical of the headwater stream reaches near Antelope Place and Chipmunk Place are shown in Figure 9-2, Photo 6.

9.2.1 Public Comments

Public input, an important element of the watershed planning process, has been encouraged and facilitated through a number of public meetings. The first of these meetings was held on June 15, 1999, at Cheldelin Middle School. During that meeting, and a subsequent meeting on July 20, residents were encouraged to share their knowledge of problem areas and to identify opportunities for improving the health of the Sequoia Creek watershed. The public comments specific to each stream reach are in Section 9.2.5. Several public comments generally applicable to the Sequoia Creek watershed are provided below:

- "Sequoia Creek and south drainage areas never should have been channelized and now, if you take brush out of channel or deepen, it will speed up flow and flood downstream. Solution won't be simple—need to consider all factors."
- "City should require on-site impoundment to reduce the flooding."
- "What can you do along Sequoia if fence is right along the stream along with power poles and there is little room to modify stream to accommodate water? How wide is an adequate corridor width?"
- "Property along Sequoia with fence right near top of bank (altered). He is concerned about the stream system and if widening would improve flow, habitat, and downstream flow levels—he would support."
- "Sequoia Creek has already been developed and ditched. Will the new plan empower development reviews (staff, planning committee, etc.)? Looking at development [policies] for owners of new development, policies that create wider stream channels and corridors. Will individuals who buy and develop, who want to put house right on creek, will it force owner to develop and protect the stream functions? What has been done is done, but how do we protect the biological integrity of currently developed areas?"
- A concern of several members of the public. "Is there communication between the County and the City to integrate stormwater objectives and deal with development in the urban growth boundary? We need a liaison and ongoing communication."

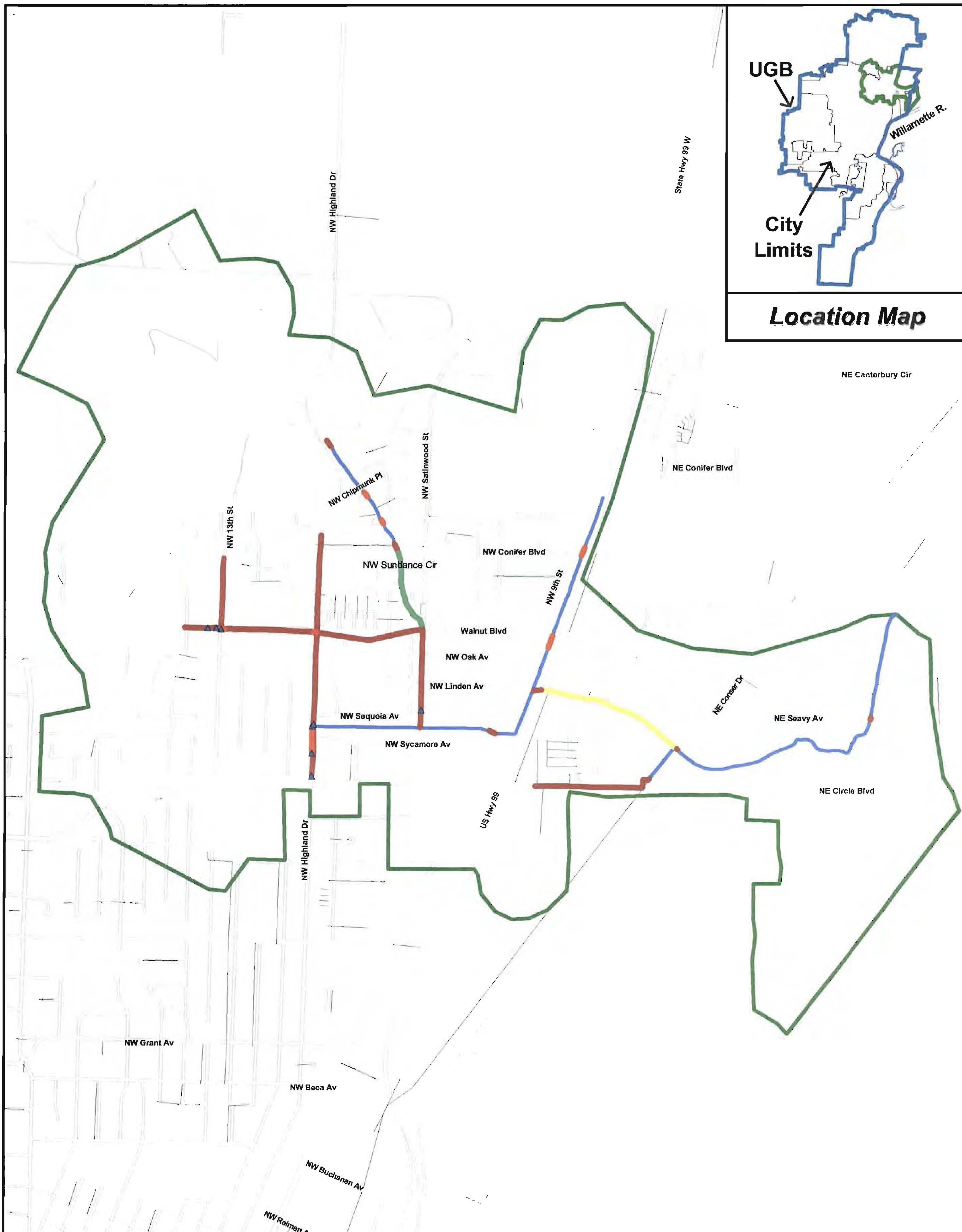


Figure 9-1 Sequoia Creek Problem Areas

LEGEND

Pipes/Bridges

Channels

Basin Boundary

Reported Problems (recorded at open house)

Surcharged Manholes (10-year future storm)

Flooded Manholes (10-year future storm)

High Velocity Areas (> 4 fps, 2-year future storm)

Undersized Conduits (10-year future storm)

Undersized Channels (10-year future storm)

CORVALLIS Public Works Department

BROWN AND CALDWELL and Associated Firms

report/figures/final/Fig9-1.wor, November 22, 2000, base data from City of Corvallis GIS Department

Figure 9-2. Watershed Photos

Photo 1. Channel conditions in the downstream reach of Sequoia Creek

Photo 2. Industrial property near Jack London Street

Photo 3. Debris in channel near Jack London Street

Photo 4. Recycling facility on Sequoia Creek stream bank

Photo 5. Culverts at Ninth Street

Photo 6. Upstream landscaping near Chipmunk Place

- "Problem is jurisdiction—Corps or DSL, County or City, State planning laws. First step—find out who has jurisdiction."

- "There were three complaints to the County recently about Sequoia Creek watershed: Highland Dell, the fill at Seavey Avenue, and various septic failures."

9.2.2 City Staff Reports

City Engineering and Utilities Operations staff is usually the first to hear from the public if problems arise. As a result of their "front-line" position, City staff members are aware of the positive and negative characteristics of the Sequoia Creek watershed. City staff helped identify known problem areas, recommended areas for stream enhancement activities, and recounted the extent and duration of flooding during major storm events. For example, the February 1996 storm caused a number of flooding problems within the watershed, including high water and road closures that occurred between Highland Drive and 9th Street.

9.2.3 Field Study Observations

Watershed Applications, a stream rehabilitation specialty firm, conducted a series of field investigations beginning in November 1997. Field personnel evaluated selected lengths of Sequoia Creek during stream walks. Their observations are included in Section 9.2.5. Detailed descriptions of the field study observations are in Appendix B.

9.2.4 Modeling Results

A computer model for the Sequoia Creek watershed identified the flow capacity of existing hydraulic structures (e.g., pipes, culverts, channels, bridge crossings) and projected existing and future flows throughout the conveyance system. The existing conditions used in the model are based on the level of development for the year 2000. Future conditions are based on the full development of the watershed (build-out) as identified in the City's Comprehensive Plan. Storm events were modeled for both the existing and future scenarios, including the 2-, 10-, 25-, and 100-year storm events. Table 9-1 lists the hydraulic structures that are undersized for the City's 10-year design storm. Modeling results for all segments over the full range of storm events are in Appendix C.

Table 9-1. Modeled Flow for Undersized Hydraulic Structures within the Sequoia Creek Watershed, cubic feet per second (cfs)

Reach/Location/Model segment	Flow capacity[1]	Existing flows 10-year storm	Future flows 10-year storm	Flooding predicted by model	Flooding reported by staff or public
Conser Street to Highway 99W/undersize channel from railroad tracks to Belvue Street (SEQ100)	230	226	234	No	Yes
Conser Street to Highway 99W/undersize channel from Belvue Street to Highway 99W (SEQ105)	102	217	225	No	No
Highway 99W to Highland Drive/culvert in Highway 99W ditch at Conifer Boulevard (SEQ145)	3.1	23.6	25.2	Yes	Yes
Highway 99W to Highland Drive/culvert in Highway 99W ditch at Walnut Boulevard (SEQ130)	5.5	28.8	30.3	Yes	Yes
Highway 99W to Highland Drive (West Branch)/ Highland Drive pipe from north (SEQ092)	57	1.4	1.4	No	Yes
Highway 99W to Highland Drive (West Branch)/ Highland Drive pipe (SEQ195)	2.1	39.6	39.6	No	Yes
Highway 99W to Highland Drive (West Branch)/ Highland Drive from south (SEQ200)	18	33.3	33.4	No	Yes
Highway 99W to Highland Drive (West Branch)/ Highland Drive from south (SEQ205)	25	13.9	13.9	No	Yes
Highway 99W to Highland Drive (West Branch)/ Walnut Boulevard west of 13th Street (SEQ250)	60	22.9	24.4	No	No
Highway 99W to Highland Drive (West Branch)/ Walnut Boulevard west of 13th Street (SEQ255)	52	22.9	24.4	No	No
Highland Drive to 13th Street (West Branch)/Walnut Boulevard east of 13th Street (SEQ245)	30	35.6	37.0	No	No
Highland Drive to 13th Street (West Branch)/Highland Drive and Walnut Boulevard pipe (SEQ231)	6.2	34.7	36.1	No	Yes
Walnut Boulevard to Headwaters (North Branch)/culvert at Chipmunk Place (SEQ335)	19	54.8	55.3	Yes	Yes
Walnut Boulevard to Headwaters (North Branch)/culvert at Antelope Place (SEQ325)	30	58.1	58.7	Yes	Yes

[1] Capacity is based on Manning's equation. It does not account for hydraulic effects from downstream backwater effects.

Most of the undersized pipes predicted by the model are in the upper reaches of the watershed, along Highland Drive. Many of the deficiencies occur where the slope of the pipe transitions from a steep gradient to the relatively flat main channel. The model shows the pipes surcharging, but not flooding during the 10-year storm event. City staff reported flooding during the 1996 storm. The channel between Conser Street and Highway 99W is shown as undersized because the capacity based on Manning's Equation is less than the projected flow, but the only reported flooding is along Conser Street at the downstream end of the stream reach.

The hydrologic/hydraulic model also estimated flow velocities. The model predicted velocities based on the 2-year storm event—the storm size most responsible for determining the channel configuration. Table 9-2 lists the modeled stream segments that exceed the 4 feet-per-second criteria.

Table 9-2. Modeled Velocities for Sequoia Creek Channel Segments Exceeding 4 fps

Reach/Model segment	2-year storm		Erosion observed	Existing bank stabilization
	Existing velocities	Future velocities		
Walnut Boulevard to Headwaters (North Branch)/ Sundance Circle to Conifer Boulevard	4.21	4.22	No	Yes
Walnut Boulevard to Headwaters (North Branch)/Satinwood culvert to Sundance Circle	4.73	4.76	No	No

9.2.5 Stream Reach Summaries

As with the other watersheds, the Sequoia Creek watershed was divided into a number of stream reaches based on physical characteristics of the stream, property ownership, and any unique characteristic that might distinguish one section of the stream from the rest. The focus of the study ranged from the headwaters to just downstream of Conser Street, where the creek reaches the city limits. The study findings are summarized in the following sections by reach description. Public comments are shown as they were recorded during public meetings or as provided by the various sources.

Downstream of Conser Street

Public Comments: "Has seen changes to downstream flows over the past years—the flashiness of it (downstream of Corvallis) at Stewart Slough."

"Culvert is too small in stretch at Highway 20."

"Man has a number of goats—2 years ago—along Stewart Slough during flooding."

"During flooding of Stewart Slough, the water was high and she (the speaker) was worried about her plantings. (She had moved the fence back and done plantings.) But, after flooding, the plants were still there and the bank was in good shape and the plantings had benefited from it. Though it takes several years to get it going."

"He owns 10 acres on Seavey Avenue along Stewart Slough and last year he picked up 2 loads of tires and other garbage. Also wood in channel."

"Lives in Seavey area near Sequoia Creek in floodplain. State (DSL) approved fill of 1,300 cubic yards (250 truckloads and they have a permit to do this). Driveway and barn are in an annual floodplain. This has been finished. An additional 1,000-1,500 cubic yards of dirt [also added]. County okayed this additional amount (no permit for this). Much of this dirt is not compacted—is loose."

City Staff Reports: Downstream property owners have made changes to the stream bank that have impacted flow capacity and stream habitat. The Walnut Boulevard Extension Project will improve the stream corridor in this area.

Field Observations: No field observations were taken for this reach.

Modeling Results: Modeling did not show any capacity or velocity deficiencies in this reach.

Conser Street to Highway 99W

Public Comments: No public comments were provided for this reach.

City Staff Reports: Low gradient stream is prone to sediment deposits that impact flow.

Field Observations: Approximately 350 feet upstream of the Willamette and Pacific Railroad tracks, the stream crosses through a 7-foot-diameter metal culvert that is about half filled with rock and silt. Downstream of Jack London Street, light industrial facilities encroach on the stream corridor. Debris and sediment from construction activities restrict the channel capacity in this reach. The stream corridor between Belvue Street and Jack London Street is a relatively high-quality riparian woodland. Some blackberry thickets are present among otherwise native species. The low-gradient stream flows through silt/clay materials with streambanks 4 to 6 feet high. A deep deposit of soft sediments has accumulated immediately downstream of Belvue Street where a dense willow thicket is crowding the channel. Raccoon tracks were present in this reach during the field survey.

The channel downstream of the railroad bridge has good canopy coverage along the south bank, but the width of the riparian buffer is confined by a trailer court along the south bank and the recycling center on the north bank. Trash in the stream is believed to be from the recycling center. The railroad bridge contains a hardened invert that has created a backwater pool upstream of the hardened area. There are substantial deposits of fine sediments immediately upstream of the box culverts at Belvue Street. The deposits have been stabilized in places by reed canarygrass. A partially silted, 36-inch-diameter culvert at Highway 99W carries the low flows, and twin box culverts positioned at a higher elevation convey water only during larger flow events. A discarded picnic table is blocking the northern box culvert under Highway 99W.

Modeling Results: The modeling showed that the stream channel was undersized from the railroad tracks near Conser Street up to Highway 99W. No reports of flooding have been received for this reach of stream. Velocities in excess of the 4 feet-per-second criteria were not predicted.

Highway 99W to Highland Drive

Public Comments: "Check out culvert in this area. [Maintenance] gate has not been locked because of blackberries at 950 NW Sequoia Street."

Nutria are a problem along Sequoia ditch, eat his lawn and chase people too. Also a large tree in the channel."

"Nutria attacked a toddler (they are territorial)."

"Citizens were involved in 1981 Drainage Master Plan and nothing was done along Sequoia ditch. Money went elsewhere—stream now 20 feet wide in 9th Street area."

"A couple of years ago, frogs on Sequoia Creek were killed and they are just now coming back."

City Staff Reports: Low gradient stream is prone to sediment deposits that impact flow. The City has little to no access to perform stream maintenance activities. Storm pipes to the south do not drain properly even during small storm events.

Field Observations: The channel between Highway 99W and 9th Street is narrow and has a sharp left bend at Highway 99W, followed by a sharp right bend underneath 9th Street. The bends, along with the berm that splits the channel, significantly decrease the channel conveyance capacity. The three box culverts under 9th Street contain large deposits of fine sediments. Directly upstream of 9th Street the creek is channelized, incised, and flat. The stream bottom is covered with fine sediments; the banks are stable and well vegetated with a mixture of native and exotic species. Man-made and woody debris block some sections of the channel.

A large, concrete, arch pipe conveys flows from the piped systems to the north and west into Sequoia Creek about 150 feet east of Fairlawn Street. The instream habitat conditions are very poor in this section of the reach. Coupled with the extensive piped systems upstream, this section has low rehabilitation potential for fish.

Modeling Results: Modeling showed capacity deficiencies along the Highway 99W ditch. A number of the pipe systems feeding into the main channel from Highland Drive are under capacity. The modeling showed no excessive velocities in this reach.

Highland Drive to 13th Street (West Branch)

Public Comments: No comments available for this reach.

City Staff Reports: No comments available for this reach.

Field Observations: No field observations were performed for this reach.

Modeling Results: The model predicted an undersized pipe at the intersection of Highland Drive and Walnut Boulevard. An undersized pipe at Walnut Boulevard and 13th Street appears responsible for surcharged manholes along Walnut Boulevard. Neither area had reports of flooding, so no action is recommended at this time. No velocity problems were reported because the modeled portion of this reach is entirely piped.

Highland Drive to Walnut Boulevard (North Branch)

Public Comments: "Why was Sequoia Creek piped over a decade ago downstream of Walnut Boulevard?"

City Staff Reports: The outlet of the arch pipe into Sequoia Creek can become partially plugged with sediment and debris.

Field Observations: No field observations were performed for this reach.

Modeling Results: The model did not predict flow capacity or velocity problems in this reach.

Walnut Boulevard to Headwaters (North Branch)

Public Comments: Sequoia [Creek] on Chipmunk [Place]: in summer sometimes a pulse of water comes down (1 or 2 times/year, a great amount of water comes down) and [its] not associated with rainfall. Reservoir overflow?"

"Chipmunk Place on Sequoia [Creek] has changed radically over past 20 years because of upstream development—some downcutting and erosion. He is concerned that if a culvert plugs, he is worried about consequences."

City Staff Reports: Culverts under Chipmunk Place and Antelope Place were designed to be undersized for the 10-year storm event and to detain water behind them.

Field Observations: No field observations were performed for this reach.

Modeling Results: Modeling showed the culverts under Chipmunk Place and Antelope Place were undersized (see City Staff Reports). Velocities exceeding the 4 feet-per-second criteria were projected for the area near Sundance Circle, between Walnut and Conifer Boulevards.

9.2.6 Watershed Summary

The downstream portions of the Sequoia Creek watershed contain some of the higher quality riparian areas observed during the overall study. Development in the lower reaches is light and has not yet encroached on the natural riparian stream buffer or on the stream itself. The mixed commercial and residential development between the Willamette and Pacific Railroad bridge and Fairlawn Street has encroached on the stream and reduced the quality of the riparian area. Also, this area is relatively flat, with a number of flow capacity deficiencies observed during the 1996 storms. The model indicates the deficiencies occur either during transitions from steep pipes to flat channels or where in-channel constrictions, such as sharp bends, exist. The water quality from the commercial areas is suspected to be low due to the absence of onsite water quality treatment facilities. Residential development in the upper reaches is low density, but vegetation management practices have reduced the quality of the riparian area and have increased the potential for water pollution, particularly from nutrients (fertilizers).

9.3 WATERSHED MANAGEMENT OPTIONS

Recommendations for the Sequoia Creek watershed are shown in Table 9-3. The short-term program elements listed in Table 9-4 include a large number of City maintenance activities. A stream stewardship program is recommended for educating and engaging the public. Such a program will help the public understand the impacts of maintenance and landscaping practices on water quality and stream health. Another recommendation is a pipe to divert flows from Fairlawn Street to the east along Linden Avenue. Detention was considered, but a lack of vacant land for off-line storage precluded this. The diversion alternative provides a direct flow path to the channel downstream of Highway 99W. It should alleviate flooding problems south of Sequoia Avenue and along 9th Street, caused in part by the existing channel configuration. The location of the diversion and other short-term projects are shown in Figure 9-3.

Additional flood protection would be provided by the recommendations listed in Table 9-5 for the long-term SWMP options. These consist of replacing several sections of undersized pipes and culverts, and improving the flood storage capacity in or along the channel. A predesign effort would be required to site and size these improvements. Figure 9-4 shows the location of the long-term projects.

Table 9-3. Sequoia Creek Options

Reach	Abridged observations	Recommended activity	Priority
Downstream of Conser Street	1) The public reported that flows have become flashier over the last few years.	a. Monitor flows to determine stream response to rain events. Use information to provide additional calibration of hydraulic model.	Short-term
	2) Culvert at Highway 20 is undersized according to public input.	a. Notify ODOT of public concern regarding capacity of culvert.	Short-term
	3) A driveway and barn were recently built in the annual floodplain according to one public observation. Also, it was noted that Benton County approved additional filling for this project without a permit.	a. Develop coordination plan with Benton County to provide review and input from City or County where project in one jurisdiction's floodplain may impact the other.	Short-term
	4) Downstream property owners have impacted flow capacity and stream habitat.	a. Develop stream stewardship program with property owners, Benton County, and City involvement with particular attention to landscaping practices impacting water quality and habitat. (Note: the Walnut Boulevard Extension Project will improve the stream corridor in this area.)	Short-term
Conser Street to Highway 99W	1) Low gradient stream is prone to sediment deposits near Belvue Street that impact flow.	a. Remove sediment near Belvue Street and work to minimize sources.	Short-term
	2) Culvert 350 feet upstream of railroad tracks is half filled with sediment.	a. Remove sediment from culvert upstream of railroad tracks and work to minimize sources.	Short-term
	3) Light industrial facilities encroach on the stream downstream of Jack London Street.	a. Develop citywide requirements for protecting remaining stream riparian areas.	Ongoing
		b. Develop citywide requirements for stormwater treatment from commercial and industrial land uses.	Ongoing
	4) Debris and sediment from construction activities restrict stream capacity downstream of Jack London Street.	a. Remove sediment downstream of Jack London Street and work to minimize sources.	Short-term
		b. Develop citywide requirements for preventing erosion from construction sites.	Ongoing
	5) Some blackberry thickets along bank between Jack London and Belvue Streets.	a. Remove non-native vegetation and replant with native species between Jack London and Belvue Streets.	Short-term

Table 9-3. Sequoia Creek Options (continued)

Reach	Abridged observations	Recommended activity	Priority
Conser Street to Highway 99W (cont.)	6) The recycling center is a source of trash found in the creek.	a. Work with recycling center to adopt Best Management Practices to prevent trash and debris from entering stream.	Short-term
		b. Investigate if parking lot/storage area at recycling center can be reduced in size to allow for vegetative buffer strip and increased capacity.	Short-term
	7) A picnic table is blocking the northern box culvert under Highway 99.	a. Remove trash and debris from culvert under Highway 99 and dispose of properly.	Short-term
Highway 99W to Highland Drive	1) Culvert at 9th Street is undersized according to public comment.	a. The model did not predict flooding in this area. Monitor flows at this location to determine the extent and nature of flooding. Provide additional capacity if required. Use flow monitor information to provide additional model calibration.	Short-term
	2) The public has reported that nutria are a problem in this reach.	a. Remove nutria from area if they become a nuisance.	Short-term
	3) Low gradient stream is prone to sediment deposits that impact flow.	a. Remove sediment deposits in stream reach and work to decrease sources.	Short-term
	4) City has little to no access to perform stream maintenance activities.	a. Develop conservation easements with property owners to protect stream and provide City access for maintenance activities.	Short-term
	5) City staff reports that storm pipes to the south do not drain properly even during small storm events. Pipe systems feeding into the main channel from Highland Drive are undersized according to the model.	a. Determine if undersized pipes along Highland Drive need to be replaced after the downstream capacity is increased.	Long-term
	6) The bends and berm that split the channel near Highway 99W decrease channel capacity causing flooding along 9th Street. The model predicted inadequate flow capacity for culverts along Highway 99W.	a. Coordinate with ODOT to remove existing berm located between two ditches and replace culverts along Highway 99W to increase carrying capacity of channels.	Long-term

Table 9-3. Sequoia Creek Options (continued)

Reach	Abridged observations	Recommended activity	Priority
Highway 99W to Highland Drive (cont.)		b. Install pipe along Linden Avenue between Fairlawn Street and Highway 99W to divert some flow away from Sycamore Avenue and the 9th Street/ Highway 99W stream sections.	Short-term
	7) The three box culverts under 9th Street contain large deposits of fine sediments and man-made debris blocks some sections of the channel.	a. Remove man-made debris from channel.	Short-term
	8) Instream habitat conditions are very poor in this reach.	a. Develop citywide requirements for protecting and enhancing existing riparian areas through conservation easements.	Ongoing
		b. Develop stream stewardship program with property owners, Benton County, and City involvement with particular attention to landscaping practices impacting water quality and habitat.	Ongoing
	9) Upstream of Highway 99W, the creek is channelized and incised with very flat gradient.	a. Investigate potential for laying back the streambank to improve flow regime and provide for greater flood storage.	Long-term
Highland Drive to Walnut Boulevard (North Branch)	1) Public noted that Sequoia Creek was piped downstream of Walnut Boulevard.	a. Develop citywide requirements for protecting existing stream functions.	Ongoing
	2) Outlet of arch pipe into creek can become partially plugged with sediment and debris.	a. Monitor sediment buildup at pipe and remove sediment and debris if flooding impacts are unacceptable and actions do not impact habitat value.	Short-term

Table 9-3. Sequoia Creek Options (continued)

Reach	Abridged observations	Recommended activity	Priority
Walnut Boulevard to Headwaters (North Branch)	1) A pulse of water has been noted near Chipmunk Place not associated with rainfall according to one public report.	a. Investigate source and legality of non-stormwater discharges near Chipmunk Place.	Short-term
	2) One citizen noted that upstream development has caused downcutting and erosion in the stream.	a. Develop citywide requirements for preventing additional runoff volume and excessive velocities due to new or re-development.	Ongoing
	3) The model predicted velocities near Sundance Circle in excess of the velocity criterion.	a. Provide channel and stream improvements to control erosion along Sundance Circle in areas where streambed or streambank have not already been armored with riprap.	Long-term
		b. Develop citywide requirements for preventing additional runoff volume and excessive velocities due to new or re-development.	Ongoing
	4) The model predicted undersized culverts at Chipmunk Place and Antelope Place. (Note: City staff reports that the culverts were designed to retain water upstream of the culverts as part of detention system.)	a. Raise elevation of Chipmunk Place and Antelope Place to continue to allow ponding behind culvert without flooding road.	Long-term
		b. Increase storage capacity of channel directly upstream of culverts.	Long-term

Table 9-4. Sequoia Creek Short-Term Program

Reach	Recommended activity	Capital cost ($)	Annual O&M ($)	Project type[1]
Downstream of Conser Street	1) Monitor flows to determine stream response to rain events. Use information to provide additional calibration of hydraulic model.	5,000	5,800	
	2) Notify ODOT of public concern regarding capacity of culvert.	200	NA	
	3) Develop coordination plan with Benton County to provide review and input from City or County where project in one jurisdiction's floodplain may impact the other.	800	NA	
	4) Develop stream stewardship program with property owners, Benton County, and City involvement with particular attention to landscaping practices impacting water quality and habitat. (Note: the Walnut Boulevard Extension Project will improve the stream corridor in this area.)	1,200	NA	
Conser Street to Highway 99W	1) Remove sediment near Belvue Street and work to minimize sources.	NA	1,100	
	2) Remove sediment upstream of railroad tracks and work to minimize sources.	NA	2,200	
	4) Remove sediment and construction debris downstream of Jack London Street.	NA	4,000	
	5) Remove non-native vegetation between Jack London and Belvue Streets and replant with native species.	12,000	600	
	6) Work with recycling center to adopt Best Management Practices to prevent trash and debris from entering stream.	400	NA	
	7) Investigate if parking lot/storage area can be reduced in size to allow for vegetative buffer strip and increase channel capacity.	3,400	NA	
	8) Remove trash and debris from culvert under Highway 99W and dispose of it.	NA	400	

Table 9-4. Sequoia Creek Short-Term Program (continued)

Reach	Recommended activity	Capital cost ($)	Annual O&M ($)	Project type[1]
Highway 99W to Highland Drive	1) The model did not predict flooding in this area. Monitor flows at this location to determine the extent and nature of flooding. Use flow monitor information to provide additional model calibration.	5,000	5,800	☑
	2) Remove nutria from area if they become a nuisance.	NA	500	⚒
	3) Remove sediment deposits in reach and work to decrease source.	NA	600	⚒
	4) Develop conservation easements with property owners to protect stream and provide City access for maintenance activities.	4,000	NA	⚒
	6) Install pipe along Linden Avenue between Fairlawn Street and Highway 99W to divert some flow away from Sycamore Avenue and the 9th Street/Highway 99W stream sections.	169,000	NA	Red line
	7) Remove man-made debris from channel at 9th Street.	NA	400	⚒
Highland Drive to Walnut Boulevard (North Branch)	1) Monitor sediment buildup at pipe and remove sediment and debris downstream if flooding impacts are unacceptable and actions do not impact habitat value.	NA	2,000	☑
Walnut Boulevard to Headwaters (North Branch)	1) Investigate source and legality of non-stormwater discharge near Chipmunk Place.	800	NA	☑
Total		**201,800**	**23,400**	

NA – Not applicable

[1]Project types are in the Figure 9-3 map legend.

Table 9-5. Sequoia Creek Long-Term Program

Reach	Recommended activity	Capital cost ($)	Annual O&M ($)	Project type[1]
Highway 99W to Highland Drive	5) Determine if undersized pipes along Highland Drive need to be replaced after the down-stream capacity is increased.	166,000	NA	
	6) Coordinate with ODOT to remove existing berm located between two ditches and replace culverts along Highway 99 to increase carrying capacity of channels.	75,000	3,750	
	9) Lay back the streambank to improve flow re-gime and provide for greater flood storage.	120,000	6,000	
Walnut Boule-vard to Headwaters (North Branch)	1) Provide channel and stream improvements to control erosion near Sundance Circle where streambed or streambank have not already been armored with riprap.	35,000	1,750	Green line
	2) Raise elevation of Chipmunk Place and Ante-lope Place to continue to allow ponding behind culvert without flooding road.	25,000	NA	
	3) Increase storage capacity of channel directly upstream of Chipmunk Place and Antelope Place culverts.	40,000	2,000	
Total		**461,000**	**13,500**	

NA – Not applicable

[1]Project types are in the Figure 9-4 map legend.

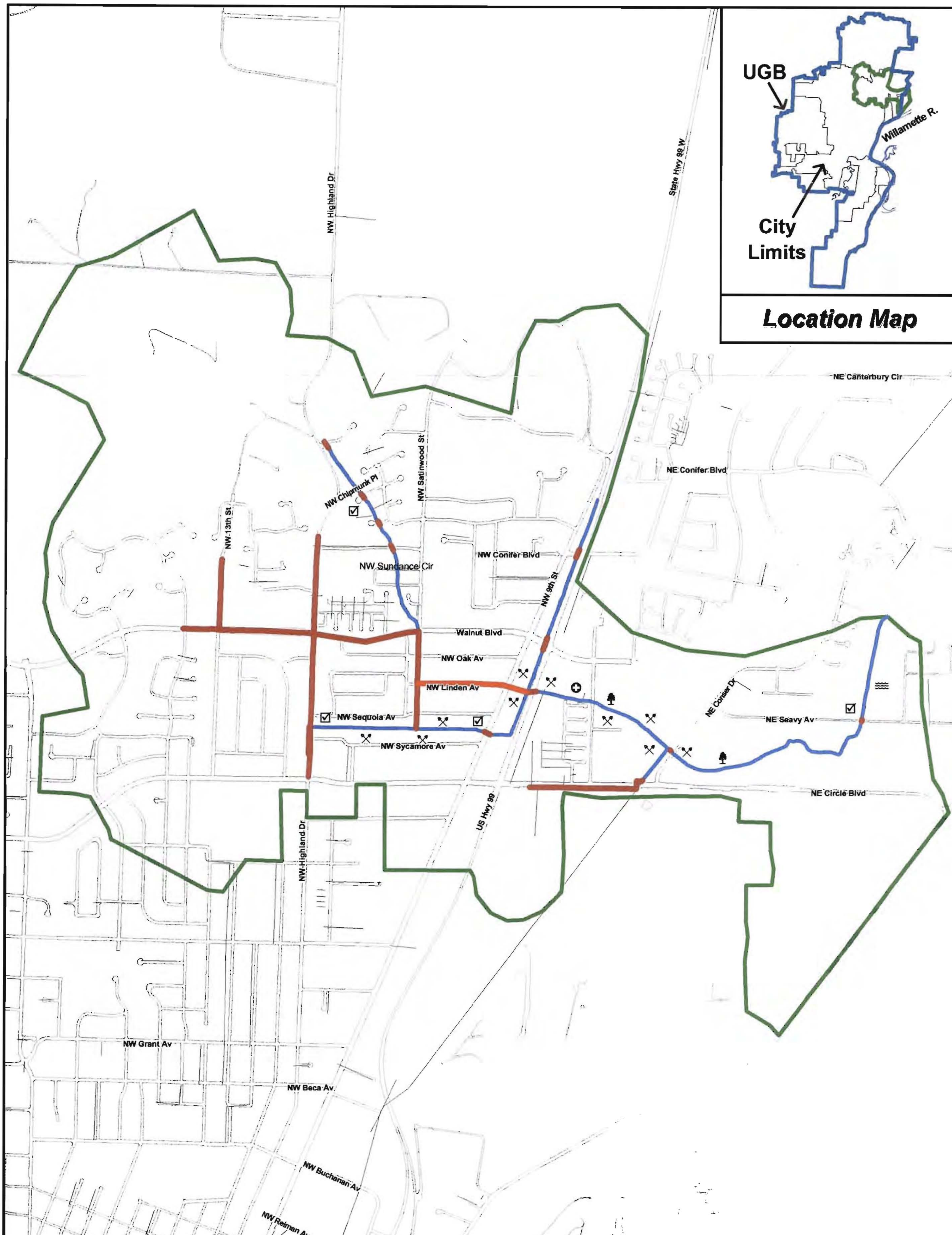


Figure 9-3 Short Term Project Locations

LEGEND

- Pipes/Bridges
- Channels
- Basin Boundary
- Bank Stabilization
- Canopy Revegetation
- Channel Improvement
- Replace Pipe/Bridge
- Fish Passage
- Buffer/Riparian Habitat
- Floodplain Reconnection
- Water Quality BMP
- Flood BMP
- Maintenance
- Monitor
- Multi-Use Facility

N

CORVALLIS Public Works Department

BROWN AND CALDWELL and Associated Firms

report/figures/final/Fig9-3.wor, November 22, 2000, base data from City of Corvallis GIS Department

CHAPTER 10

WATERSHED PLANNING AND ANALYSIS: GARFIELD BASIN

10.1 INTRODUCTION

The Garfield watershed lies between the Dixon Creek watershed to the south and the Sequoia Creek watershed to the north. The topography of the watershed is flat with slopes of less than 3 percent. The watershed's soils are poorly drained silts, reflecting the area's origin as alluvial terraces formed by the Willamette River. The upper reaches of the watershed are almost completely developed and their high degree of imperviousness contributes to much of the flows through the relatively undeveloped reaches downstream of Highway 99. Most of the watershed also experiences a high groundwater table that reduces the volume and rates of stormwater infiltration.

The Garfield watershed contains less than 350 acres, making it one of the smallest watersheds in the Corvallis area. Currently, 70 percent of the watershed is zoned industrial. The City's comprehensive zoning indicates that, in the future, the zoned industrial area may decrease to 61 percent; however, the amount of impervious surfaces will remain constant due to an increase in commercial zoning.

Widespread road closures occurred in the Garfield watershed during the February 1996 flood event. Closures were reported in the upper reaches of the Garfield drainage system, along 9th Street, Garfield Avenue, and Cleveland Avenue.

10.2 WATERSHED FINDINGS

Information on watershed conditions was obtained by working with City staff to identify maintenance and operation problems, and by modeling the conveyance system for the existing and future build-out scenarios. Figure 10-1 identifies the layout of the Garfield watershed drainage system and some of the major observations made during the watershed study.

The drainage system in the lower reaches of the Garfield watershed consists mostly of open channels. The channels flow through City property that, for the most part, has a vegetative buffer between the channel and developed areas, as shown in Figure 10-2, Photo 1. Canopy coverage is generally good in the lower reaches, with large trees and thickets of willows bordering the channel. The channel is dry in the summer and consists mainly of packed earth, as shown in Figure 10-2, Photo 2. Little or no canopy exists from the railroad tracks to the upper reaches. Much of the vegetation along the channel in this upper reach is blackberry thicket, as shown in Figure 10-2, Photo 3. The channel bottom consists of bare earth; gravel and woody debris are absent from most of the channel as shown in Figure 10-2, Photo 4. The channel and streambanks provide little habitat value and show signs of eroding during storm flows.

10.2.1 Public Comments

Public input into the citywide watershed planning process has been encouraged and facilitated through a number of public meetings, although no meetings were held specifically for the Garfield watershed. Comments specific to the Garfield watershed were not received in any of the citywide meetings held during the course of the project.

10.2.2 City Staff Reports

City Engineering and Utilities Operations staff is familiar with the Garfield watershed. Not only is City staff involved with the review of development plans and maintenance of drainage facilities, but Corvallis Public Works offices and shops are located within the lower reaches of the Garfield watershed. City staff is therefore uniquely aware of conditions in and along the channel. City staff provided input into the planning process by identifying known problem areas, recommending areas for stream enhancement activities, and recounting the extent and duration of flooding during major storm events. The City provided extensive records of flooding in the Garfield watershed during the February 1996 flood.

10.2.3 Field Study Observations

Field investigations in portions of the lower reaches of the Garfield watershed, downstream of Highway 99, were conducted in August 2000. The piped drainage system in the upper reaches was not observed. The entire system was dry during the investigation, thus limiting habitat value for fisheries or amphibious wildlife. The highest value canopy coverage was found on City property downstream of the railroad, although this area has been used to store construction debris and machinery.

10.2.4 Modeling Results

A computer model for the Garfield watershed identified the hydraulic capacity and projected flows in the culverts and channels of the conveyance system for existing and future build-out scenarios. The model based existing conditions on land use information from the City's GIS maps. Future conditions were based on full development of the watershed (build-out) as identified in the City's Comprehensive Plan. Field observations revealed that much of the area currently identified as industrial has not yet been developed; hence, the modeled flows for the existing scenario may be higher than those that actually occur in the field.

A full range of storm events was modeled for the existing and future scenarios, including the 2-, 5-, 10-, 25-, and 100-year storm events. Table 10-1 lists the hydraulic structures (pipes, culverts, bridge crossings, channels, etc.) that are undersized for the City's 10-year design storm. A complete summary of all modeled segments is in Appendix C.

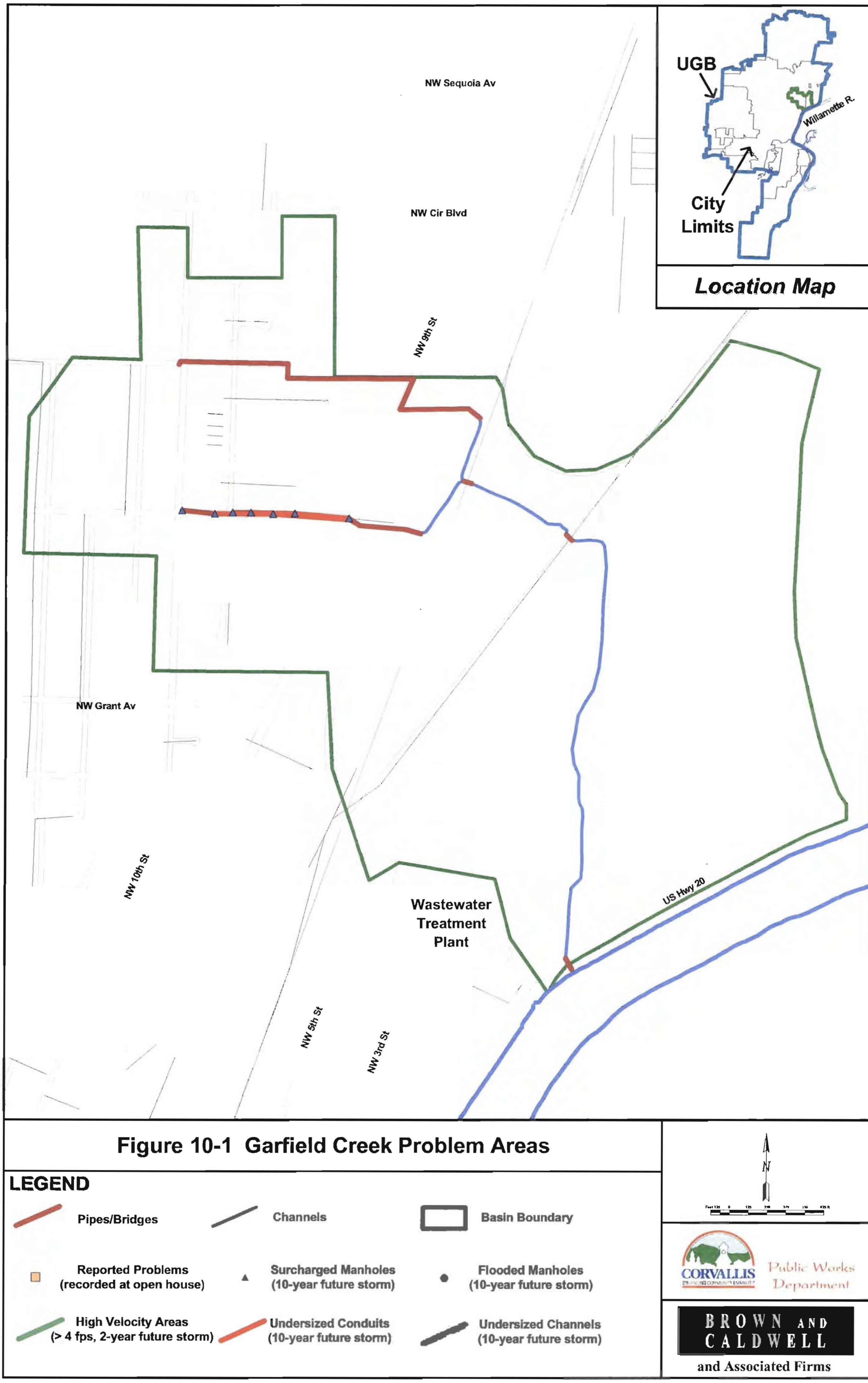


Figure 10-1 Garfield Creek Problem Areas

report/figures/final/Fig10-1.wor, November 6, 2000, base data from City of Corvallis GIS Department

Figure 10-2. Watershed Photos

Photo 1. Channel upstream of Highway 20.

Photo 2. Channel near access road, downstream of railroad.

Photo 3. Blackberry thickets along railroad tracks.

Photo 4. Exposed channel bottom between Highway 99 and railroad tracks.

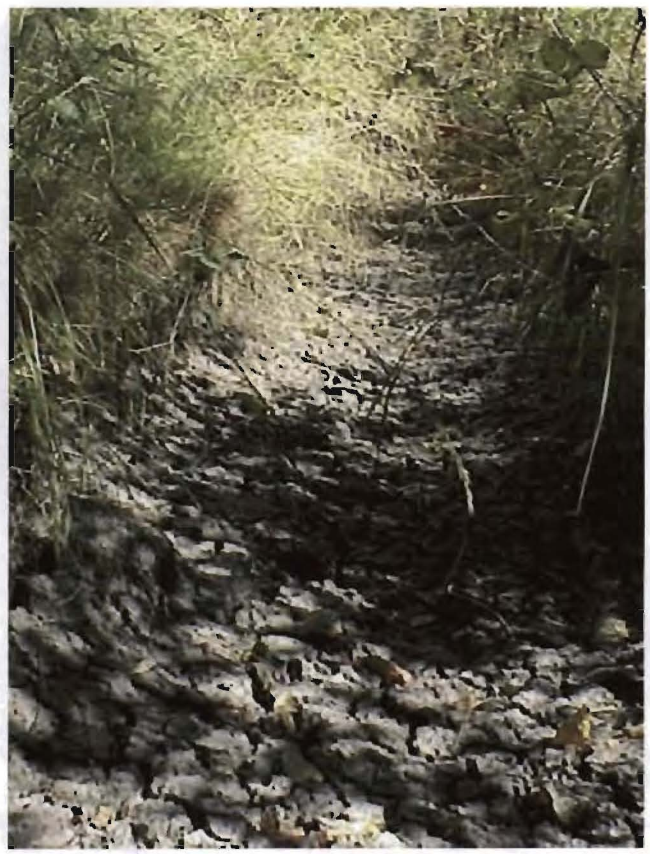


Table 10-1. Modeled Flow for Undersized Hydraulic Structures within the Garfield Watershed, cubic feet per second (cfs)

Reach/Location/Model segment	Flow capacity[1]	Existing[2] flows 10-year storm	Future[2] flows 10-year storm	Flood predicted by model	Flood reported by staff or public
Garfield Avenue, between Division Street and 9th Street (GAR095)	3.3	1.7	1.9	No	Yes
Garfield Avenue, between Division Street and 9th Street (GAR090)	3.2	4.2	4.4	No	Yes
Garfield Avenue, between Division Street and 9th Street (GAR085)	3.5	4.2	4.4	No	Yes
Garfield Avenue, between Division Street and 9th Street (GAR080)	19	4.2	4.4	No	Yes
Garfield Avenue, between Highland Drive and Division Street (GAR075)	7.7	7.6	7.6	No	Yes
Garfield Avenue, between Division Street and 9th Street (GAR070)	7.4	7.6	7.6	No	Yes
Garfield Avenue, between Division Street and 9th Street (GAR065)	7.1	7.5	7.5	No	Yes

[1] Capacity is based on Manning's Equation.
[2] Model results are based on dynamic routing and may result in a lower capacity than reported by Manning.

Only a few sections of the conveyance system are undersized according to the model results. The first is along Garfield Avenue from Highland Drive to 9th Street. Pipes in this section are constructed with a low gradient (low slope) and downstream constrictions cause water to back up within the system. The culvert at Highway 99 failed to pass the 10-year design storm event. This culvert has a diameter of 3 feet and is downstream of two 4-foot culverts that convey flow beneath the two railroad crossings. Although undersized, the culvert installation at Highway 99 appears to have adequate storage and freeboard to safely back up water without threatening property or the structural integrity of the highway.

Backwater from the Marys and Willamette Rivers was not included in the model, since the flooding problems associated with these two rivers cannot be solved by channel improvements in the Garfield watershed.

The hydrologic/hydraulic model also estimated stream velocities in channel segments to determine areas at risk for channel or streambank erosion. Stream velocities in excess of 4 feet per second (fps) may cause erosion of the streambank or streambed. A 2-year storm event—the storm size most responsible for determining the channel configuration—was used to predict channel velocities. None of the channel velocities in the Garfield watershed exceeded the 4 feet-per-second criteria.

10.2.5 Stream Reach Summaries

The Garfield watershed was divided into four stream reaches. The first reach begins at the outfall to the Willamette River and continues upstream to the northeast edge of the Corvallis Wastewater Treatment Plant (WWTP) storage lagoons. The second stream reach runs from the storage lagoons to the east railroad crossing. The third reach runs from the east railroad crossing to Highway 99. The fourth reach included all of the piped drainage system upstream of Highway 99.

Willamette River to WWTP Lagoons

Public Comments: No public comments were received.

City Staff Reports: No staff comments received pertaining to this reach.

Field Observations: The channel was dry during the summer field investigation. The bottom is exposed soil through most of the reach. The banks are covered with a heavy growth of willows and other shrubs. Several acres along the channel are maintained as a grassy meadow. Entrance to the meadow is via an access road over a small culvert. The access road and culvert are just upstream of the fire station training area. Flows exceeding the capacity of the culvert flow over the access road without causing flooding problems. Some sections of the WWTP expansion are located close to the channel in this reach. The fire station training area is located close to the channel as well, and may present a water quality concern due to chemicals used to put out practice fires.

Modeling Results: Modeling showed no flow velocities exceeding the 4 feet-per-second erosion criteria. The culvert under Highway 20 is undersized during the 10-year storm event, but there appears to be adequate storage volume in the overbank area for water that leaves the main channel.

WWTP Lagoons to East Railroad Crossing

Public Comments: No public comments were received.

City Staff Reports: The City uses the access road behind the Public Works facilities to store construction debris. This practice is currently under evaluation.

Field Observations: The area that drains to this stream reach is mostly undeveloped. The existing woods show signs of past high water. A gravel access road runs from the Public Works facilities along the railroad tracks back to the drainage channel. The City's Public Works Department uses the area for disposing construction debris and machinery. The drainage channel has good canopy coverage, but the bare earth bottom has little habitat value. A poorly maintained dirt track starts at the access road turn-around and runs along most of the channel length. This track crosses the road at an iron pipe used for a culvert. It appears that any substantial flow in the channel overtops the pipe and runs across the dirt track.

Modeling Results: Modeling showed no flow velocities exceeding the erosion criteria. No culverts were modeled in this reach. The iron pipe at the track crossing is undersized by inspection, but flow is free to overtop the structure without harmful impacts to surrounding property.

East Railroad Crossing to Highway 99

Public Comments: No public comments were received.

City Staff Reports: No staff comments received pertaining to this reach.

Field Observations: This reach was investigated from Highway 99 to the western railroad track. The segment between the east and west railroad tracks was not investigated. Flows from the upstream piped system cross under Highway 99 via two culverts, about 1,000 feet apart. Both culverts discharge to a ditch between the bike path and western railroad tracks. The north culvert's outlet is located below the bottom of the ditch, reducing its capacity and causing erosion of the surrounding ditch. The remainder of the ditch has been scoured clean by stormwater flows. Canopy coverage is poor throughout this reach.

Modeling Results: Modeling showed no culvert capacity problems or flow velocities exceeding the 4 feet-per-second erosion criteria.

Piped System Upstream of Highway 99

Public Comments: No public comments were received.

City Staff Reports: During the February 1996 storm, road closures and high water were reported for 9th Street, Garfield Avenue from 9th Street to Highland Drive, Cleveland Avenue from Division Street to 11th Street, and along Division Street, up to, and including, parts of Spruce Avenue.

Field Observations: A field inspection was not done for this reach.

Modeling Results: The main stem of the piped system that drains the upper reach of the Garfield watershed was modeled. The model reports that the parallel pipe system along Garfield Avenue from Highland Drive to 9th Street surcharges under the 10-year storm event. This result corresponds to one of the high water areas reported by the City.

10.3 WATERSHED MANAGEMENT OPTIONS

Watershed management options for the Garfield watershed were developed by the consultant team, based on input from City staff, field observations, and modeling results. Table 10-2 lists recommended options that include the following:

- Ensure that an adequate stream buffer is maintained between WWTP activities and the channel.
- Plant trees along the ditch for shade.
- Conduct field investigation in cooperation with the railroad.

All of the recommendations for the Garfield watershed were assigned to the short-term program listed in Table 10-3.

Table 10-2. Garfield Options

Reach	Abridged observations	Recommended activity	Priority
Willamette River to WWTP Lagoons	1) Banks are covered with willows and other shrubs.	a. Maintenance required to thin willows and shrubs to improve flow passage.	Short-term
	2) WWTP expansion is located close to channel.	a. Ensure that adequate stream buffer is maintained between WWTP activities and channel.	Short-term
	3) Water and chemicals from Fire Station training area are a concern.	a. Coordinate with Fire Department to minimize and possibly treat fire-training flows before flows leave the site.	Short-term
WWTP Lagoons to East Railroad Crossing	1) City uses access road to store construction debris.	a. Designate confined area away from channel and high water table for debris storage.	Short-term
	2) Existing woods show signs of high water.	a. Investigate possibility of allowing woods to revert to wetlands for habitat and treatment of stormwater from upstream reaches.	Short-term
	3) Good canopy but bare earth channel.	a. Do not maintain channel, but allow it to become dispersed wetland flow.	Short-term
	4) Poorly maintained dirt track along most of channel length with an iron pipe culvert.	a. Block access to dirt track unless essential for utility services. Remove iron pipe or upgrade crossing with rock.	Short-term
East Railroad Crossing to Highway 99	1) No field investigation was conducted between the east and west railroad lines.	a. Conduct field investigation in cooperation with railroad.	Short-term
	2) Northern culvert lower than ditch bottom, causing erosion and loss of capacity.	a. Monitor extent of erosion and loss of capacity. Remove excess sediment to restore hydraulic capacity as required.	Short-term
	3) Bottom of ditch scoured.	a. Anchor woody debris in channel to help dissipate erosive forces.	Short-term
	4) Poor canopy coverage throughout the investigated part of the reach.	a. Plant trees along ditch for shade.	Short-term
Piped System Upstream of Highway 99	1) Several areas of high water and flooding of roads in this reach during February 1996 storm.	a. Conduct detailed study of the pipe hydraulics in this section of the drainage system to determine potential reasons for flooding.	Short-term
	2) Model reports surcharging pipes along Garfield Avenue.	a. Upsize pipes to prevent surcharging.	Short-term

Table 10-3. Garfield Short-Term Program

Reach	Recommended activity	Capital cost ($)	Annual O&M ($)	Project type[1]
Willamette River to WWTP Lagoons	1) Maintenance required to thin willows and shrubs to improve flow passage.	NA	1,100	
	2) Ensure that adequate stream buffer is maintained between WWTP activities and channel.	NA	400	
	3) Coordinate with Fire Department to minimize flows from site.	400	NA	
WWTP Lagoons to East Railroad Crossing	1) Designate confined area away from channel and high water table for debris storage.	2,800	NA	
	2) Investigate possibility of allowing woods to revert to wetlands for habitat and treatment of stormwater from upstream reaches.	1,640	NA	
	3) Do not maintain channel, but allow it to become dispersed wetland flow.	NA	NA	
	4) Block access to dirt track unless essential for utility services. Remove iron pipe or upgrade crossing.	2,000	NA	
East Railroad Crossing to Highway 99	1) Conduct field investigation in cooperation with railroad.	1,120	1,100	☑
	2) Monitor extent of erosion and loss of capacity. Remove excess sediment to restore hydraulic capacity as required.	NA		Yellow line
	3) Anchor woody debris in channel to help dissipate erosive forces.	4,000	600	
	4) Plant trees along ditch for shade.	24,000	1,200	Orange line
Piped System Upstream of Highway 99	1) Conduct detailed study of the pipe hydraulics in this section of the drainage system to determine potential reasons for flooding.	15,000	NA	
	2) Upsize pipes to prevent surcharging.	181,200	NA	
Total		**232,160**	**4,400**	

NA – Not applicable

[1]Project types are in the Figure 10-3 map legend.

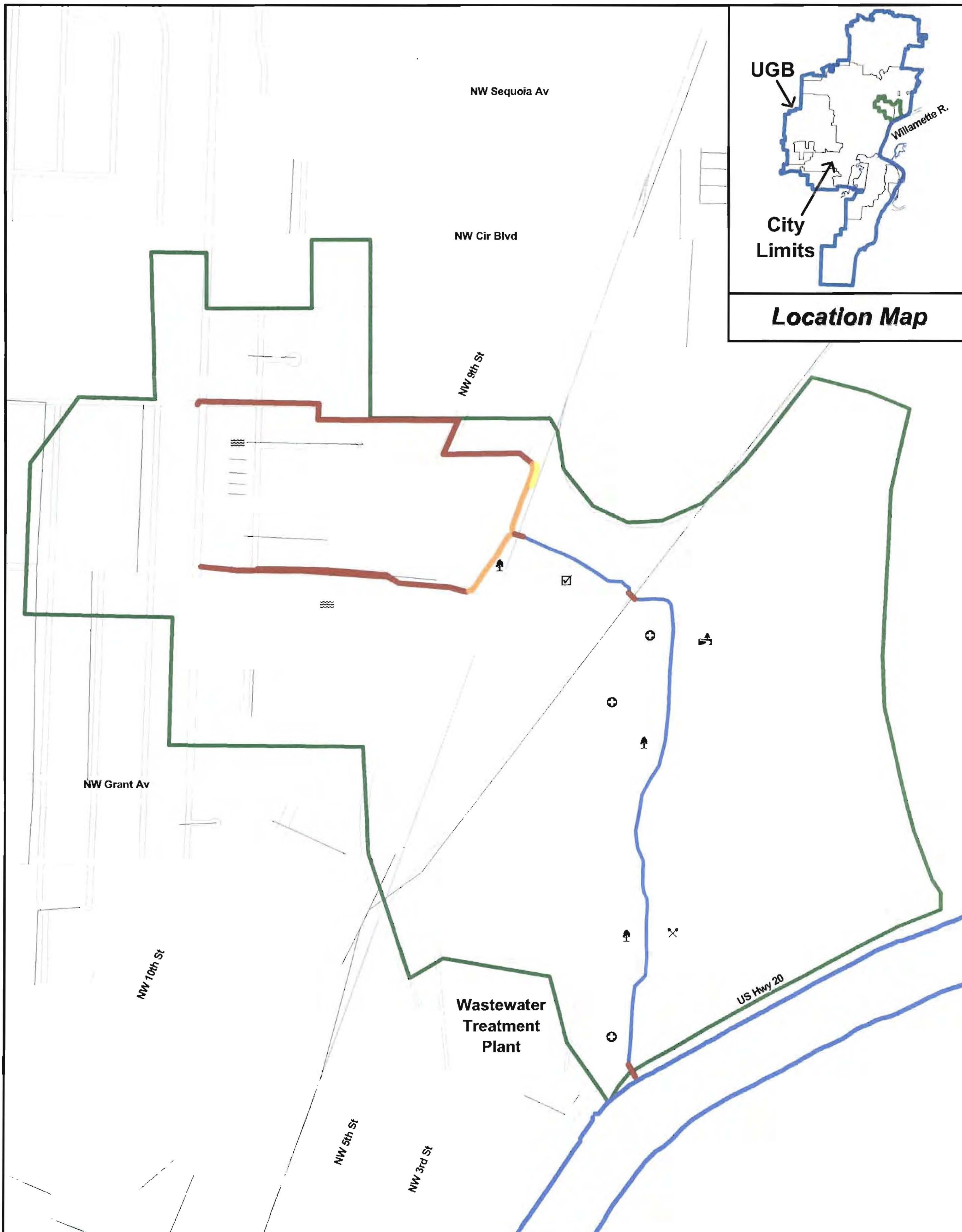


Figure 10-3 Short Term Project Locations

LEGEND

- Pipes/Bridges
- Bank Stabilization
- Replace Pipe/Bridge
- Floodplain Reconnection
- Maintenance
- Channels
- Canopy Revegetation
- Fish Passage
- Water Quality BMP
- Monitor
- Basin Boundary
- Channel Improvement
- Buffer/Riparian Habitat
- Flood BMP
- Multi-Use Facility

N

CORVALLIS
Public Works Department

BROWN AND CALDWELL
and Associated Firms

report/figures/final/Fig10-3.wor, November 6, 2000, base data from City of Corvallis GIS Department

CHAPTER 11

WATERSHED PLANNING AND ANALYSIS: OAK CREEK

11.1 INTRODUCTION

The Oak Creek watershed is the largest watershed within the study area of this plan. The upper reaches of Oak Creek lie outside of the city limits and the Urban Growth Boundary. The stream's headwaters are located northwest of Corvallis in McDonald State Forest, on the southern slopes of Cardwell Hills at about 1,400 feet in elevation. Oak Creek follows logging roads southward past Dimple Hill and Oregon State University (OSU) Experimental Station. The creek follows Oak Creek Drive, where it is joined by Alder Creek downstream of Skillings Drive. Mulkey Creek joins Oak Creek from the west, downstream of Bald Hill Park. Oak Creek flows under 53rd Street just north of Harrison Boulevard. The lower reaches lie within the city limits, beginning where Oak Creek crosses Harrison Boulevard to the south. The stream then flows southeast toward OSU. In this reach it flows through pastures and by farm buildings and research facilities before reaching the main body of the campus. On the south side of the OSU campus, the creek is bound by the Reser Stadium parking lot to the northeast, and mixed residential use to the southwest. As Oak Creek leaves OSU, it flows through a short residential section before flowing under Highway 20/34 and entering Marys River.

The Oak Creek watershed contains 8,300 acres. The largest current land use is state forest land, which covers almost 5,900 acres, representing over 70 percent of the watershed. About 12 percent of the watershed (1,030 acres) is used for agricultural purposes. OSU manages both the forest land and agricultural land. With the addition of the campus itself, OSU manages almost 90 percent of the land in the watershed. Over 500 acres are listed as undeveloped.

Under future development, the undeveloped land may be built out as light residential, and some of the OSU agricultural land may be developed for university non-agricultural purposes. The quantity of impervious surfaces in the watershed will increase only slightly under these conditions.

11.2 WATERSHED FINDINGS

Information on watershed conditions was obtained by collecting public comments at open houses, working with City staff to identify maintenance and operation problems, conducting a technical stream evaluation of selected reaches, and by modeling the conveyance system for the existing and build-out scenarios. This information was compiled by stream reach and is summarized in Section 11.2.6. A map of the Oak Creek watershed is presented as Figure 11-1. Figure 11-2 shows the location of the stream within the UGB and identifies some of the major observations made during the watershed study.

The conditions found in Oak Creek reflect the various land uses along the stream reaches. Urban influences on the stream are apparent in its lower reaches. Figure 11-3, Photo 1, shows gravel bars that form most of the channel substrate downstream of Highway 20/34. The Highway 20/34 culverts shown in Figure 11-3, Photo 2, represent a fish obstacle during low-flow conditions, but are probably not a significant barrier during winter months when Marys River runs high. The large pool of water upstream of the culverts has limited shade and the streambanks are covered with blackberry thickets, as shown in Figure 11-3, Photo 3. The canopy cover improves farther upstream, as shown in Figure 11-3, Photo 4. However, stream conditions have been degraded due to riprap and concrete debris that have been placed or dumped in the channel. The channel bottom is scoured down to soft bedrock in this stream reach with occasional deposits of densely packed gravel. A number of hoses were found in the stream originating from some of the homes located adjacent to the creek. Pumping of water for lawn and garden irrigation is suspected. Figure 11-3, Photo 5, shows the Irish Bend Bridge as reconstructed along Campus Way. It serves as an alternate crossing to the low-water ford, which also provides access to OSU's agricultural property to the west. The OSU dairy is located in the background of the photo. A manure-spreading gun, Figure 11-3, Photo 6, spreads manure stored at the dairy operation.

11.2.1 Public Comments

Public meetings were held to encourage and facilitate public input into the planning process. The first of the meetings for the Oak Creek, Marys River, and South Corvallis watersheds was held on June 17, 1999 at the LaSells Stewart Center. During that meeting and a subsequent meeting, on September 30, 1999, residents were encouraged to share their knowledge of problem areas and to identify opportunities for improving the health of the three watersheds. Public comments for specific reaches of Oak Creek are included in Section 11.2.6. General comments about the Oak Creek watershed are listed below:

- "In Urban Growth Boundary – have mixed jurisdictions (i.e. Benton County, OSU). How do we bring them into the planning/development, etc. processes?"
- "Has the SWPC looked at using permeable paving and requiring it?"
- "Retention basins may be another solution (approach) to parking lot runoff that also deals with water quality."
- "Why does the City require driveways to be paved? Why can't we use other treatment?"
- "At the moment, the City requires generously wide streets that are probably not necessary. Narrower streets could be looked at."
- "Is Oak Creek an 'essential Chinook habitat'?"
- "Spill containment plan—consider workup on, especially for industrial sites."
- "Spill containment is only one contaminant—herbicide use on green strips between street (along curb) and lawn—OSU landscaping—source of pollutants."
- "Are stream corridors being used for recreation? Have trails along streams, on detention areas as parks? i.e., multiple uses of these spaces?"

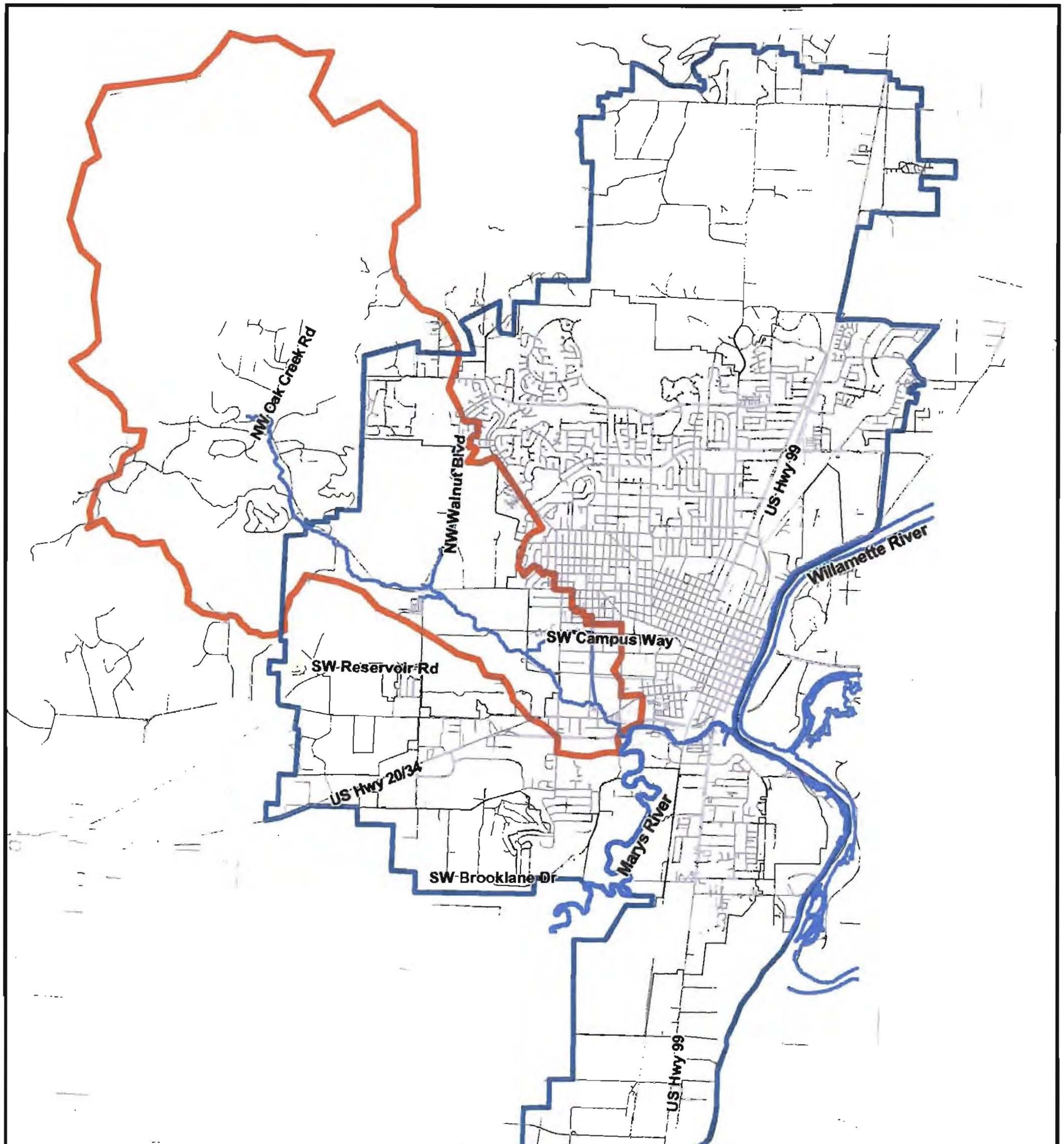


Figure 11-1 Oak Creek Watershed

LEGEND

Urban Growth Boundary

Oak Creek Watershed

City Limits

N

Public Works Department

BROWN AND CALDWELL

and Associated Firms

report/figures/final/Fig11-1.wor, November 6, 2000, base data from City of Corvallis GIS Department

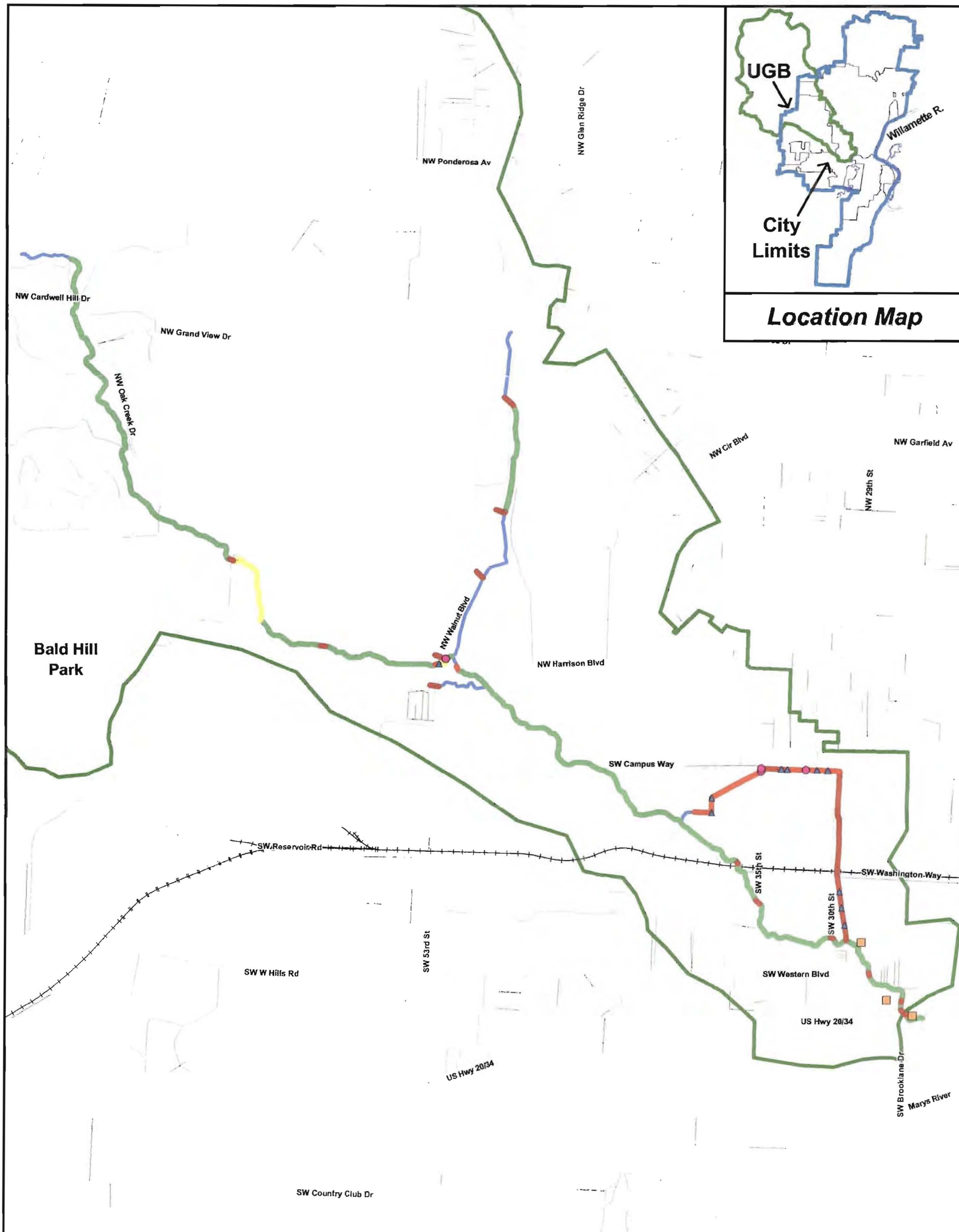


Figure 11-2 Oak Creek Problem Areas

LEGEND

Pipes/Bridges
Channels
Basin Boundary
Reported Problems (recorded at open house)
Surcharged Manholes (10-year future storm)
Flooded Manholes (10-year future storm)
High Velocity Areas (> 4 fps, 2-year future storm)
Undersized Conduits (10-year future storm)
Undersized Channels (10-year future storm)

Feet 600 0 600 1200 1800 2400 Feet

CORVALLIS Public Works Department

BROWN AND CALDWELL and Associated Firms

report/figures/final/Fig11-2.wor, November 6, 2000, base data from City of Corvallis GIS Department

Figure 11-3. Watershed Photos

Photo 1. Gravel bottom and trees near Marys River

Photo 2. Fish barrier at Hwy 20/34

Photo 3. Large pool upstream of Hwy 20/34

Photo 4. Habitat near Western Blvd.

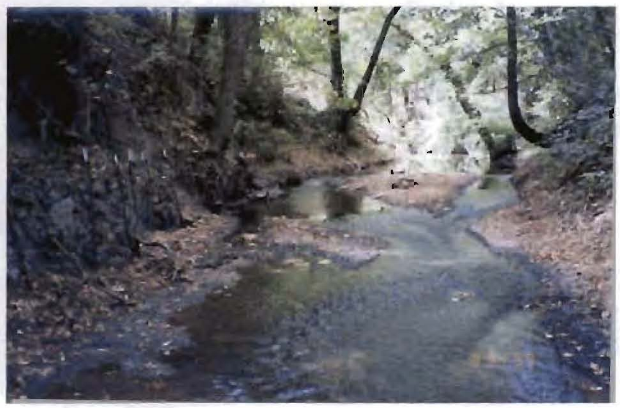
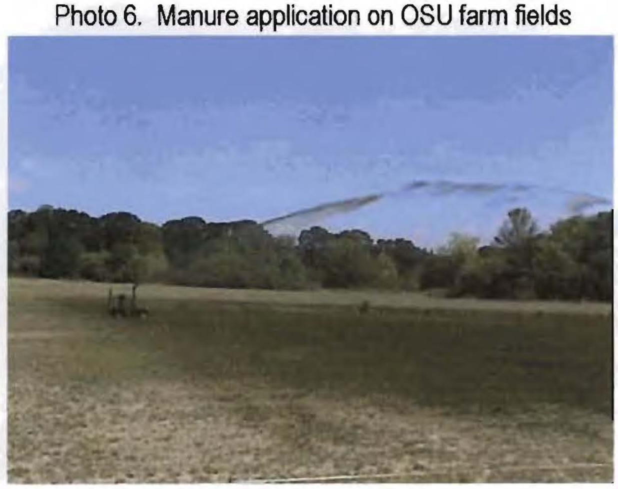


Photo 5. Irish Bend Bridge along Campus Way

Photo 6. Manure application on OSU farm fields



11.2.2 Oregon State University Oak Creek Action Team Report

In May 1999, OSU created an Action Team consisting of OSU scientists and engineers to study the impacts of university activities on the Oak Creek watershed. The findings and recommendations of the Action Team are documented in the *Report of the Oak Creek Action Team to Oregon State University*, (OSU Report, June 2000). The report identified six critical issues or activities that impact the Oak Creek basin, including:

1. Manure application and water quality
2. Riparian condition and water quality
3. Water withdrawal
4. Dams and barriers
5. Storm water drainage
6. Toxic waste storage and handling

To assess the impact of these OSU-controlled issues, the Action Team recommended the following "critical actions":

- Appoint an OSU Oak Creek governing body
- Establish an Oak Creek Riparian Study Area
- Develop environmental monitoring sites and systematic measurements in the Oak Creek Riparian Study Area
- Conduct an analysis of winter manure spreading
- Develop a policy to evaluate all structural development in the Oak Creek Riparian Study Area
- Remove dams and stop water withdrawal from Oak Creek
- Incorporate assessment of storm drains into OSU policies for hazardous waste management

Additional findings of the 12-month study are documented in the OSU Report. Excerpts of the findings are provided in Section 11.2.6.

11.2.3 City Staff Reports

City Engineering and Utilities Operations staff members are familiar with the Oak Creek watershed through their day-to-day activities. They provided input into the planning process by identifying known problem areas, recommending areas for stream enhancement activities, and recounting the extent and duration of flooding during major storm events. The February 1996 storm caused a number of flooding problems within the watershed. Most of the high water and road closures occurred in the reaches just upstream of Highway 20/34.

11.2.4 Field Study Observations

Watershed Applications, a stream rehabilitation specialty firm, conducted a series of field investigations beginning in November 1997. Field personnel evaluated selected lengths of Oak Creek during stream walks. A summary of their observations is included in Section 11.2.6. Detailed descriptions of the field study observations are in Appendix B.

11.2.5 Modeling Results

A computer model for the Oak Creek watershed identified the hydraulic capacity and projected flows in the pipes, culverts, and channels of the conveyance system for existing and future build-out scenarios. Existing conditions are based on the current level of development at the time of modeling. Future conditions are based on full development (build-out) of the watershed as identified in the City's Comprehensive Plan. A full range of storm events was modeled for the existing and future scenarios, including the 2-, 10-, 25-, and 100-year storm events. Table 11-1 lists the hydraulic structures (pipes, culverts, bridge crossings, etc.) that are undersized for the City's 10-year design storm. A complete summary of all modeled segments is in Appendix C.

Table 11-1. Modeled Flow for Undersized Hydraulic Structures within the Oak Creek Watershed, cubic feet per second

Reach/Location/Model segment	Full pipe or channel capacity[1]	10-year storm flows		Flooding predicted by model	Flooding reported by staff or public
		Existing	Future		
Western Boulevard to 35th Street/Pipe system along Campus Way flowing east (OAK415, OAK410, OAK405, OAK400)	5.7	9.5	9.5	Yes	Yes
Western Boulevard to 35th Street/Pipe system along 30th Street (OAK305)	71	37	37	No	No
Western Boulevard to 35th Street/Pipe system along 30th Street (OAK295)	127	37	37	No	No
35th Street to Harrison Boulevard/Crossing at Campus Way	75	882	886	Yes	Yes
35th Street to Harrison Boulevard/Pipe system near 35th Street (OAK375, OAK370, OAK365, OAK360)	5.4	6.8	6.8	Yes	Yes
35th Street to Harrison Boulevard/Channel by OSU dairy farm (OAK103)	17	835	835	Yes	No
Harrison Boulevard to Cardwell Hill Drive/Culvert under Harrison Boulevard (OAK115)	287	425	425	Yes	Yes
Harrison Boulevard to Cardwell Hill Drive/Channel downstream of Oak Creek Drive crossing (OAK140)	1070	1090	1090	Yes	NA

Table 11-1. Modeled Flow for Undersized Hydraulic Structures within the Oak Creek Watershed, cubic feet per second (continued)

Reach/Location/Model segment	Full pipe or channel capacity[1]	10-year storm flows		Flooding predicted by model	Flooding reported by staff or public
		Existing	Future		
Harrison Boulevard to Cardwell Hill Drive/Channel on agricultural land to east of Bald Hill (OAK150)	548	1080	1080	Yes	NA
Harrison Boulevard to Cardwell Hill Drive/Channel at entrance to Bald Hill (OAK155)	628	979	980	Yes	NA

[1] The full pipe or channel capacity is based on Manning's Equation. It does not account for hydraulic effects from downstream backwater effects.

NA – Not applicable, City staff or public input not provided for this location, usually limited to inside the city limits.

Not all of the undersized structures listed in Table 11-1 result in flooding even though some of the piped segments are surcharged. The greatest flooding problems are located away from the stream, caused by undersized pipe systems along Campus Way between 30th and 35th Streets. Most of the undersized channels and culverts along the creek occur in agricultural areas owned by OSU, where the impact of flooding is considered to be minor. One undersized culvert, at the Campus Way crossing, is designed to act as a ford during larger storm events.

The hydrologic/hydraulic model also estimated flow velocities in channel segments to determine areas at risk for channel or streambank erosion. Velocities in excess of 4 feet per second (fps) may cause erosion of the streambank or streambed. The model predicted velocities based on the 2-year storm event—the storm size most responsible for determining the channel configuration. Table 11-2 lists the reaches where the velocities exceeded 4 feet-per-second.

The model showed velocities that exceeded the erosion criteria along the majority of the stream reaches. Most of the stream reaches above 35th Street were not observed as part of this planning process. In this area, reports of erosion were based on OSU's June 2000 *Report of the Oak Creek Action Team to Oregon State University*. Field verification of actual erosion problems is required prior to implementing streambank restoration or other related management actions.

Table 11-2. Modeled Velocities for Oak Creek, Channel Segments Exceeding 4 Feet per Second

Reach/Model segment	2-year storm: Existing velocities	2-year storm: Future velocities	Erosion observed	Existing bank stabilization
Marys River to Highway 20/34 /Upstream of river	6.5	6.5	No	No
Highway 20/34 to Western Boulevard/Highway 20/34 to Morris Avenue	5.9	5.9	No	No
Highway 20/34 to Western Boulevard/Morris Avenue to Western Boulevard	5.5	5.6	Yes	Yes
Western Boulevard to 35th Street/Western Boulevard to near Grove Street	5.7	5.7	Yes	No
Western Boulevard to 35th Street/near Grove Street to 30th Street	6.2	6.2	Yes	No
Western Boulevard to 35th Street/30th Street to OSU Forestry Lab	6.1	6.1	Yes	Yes
Western Boulevard to 35th Street/OSU Forestry Lab to 35th Street	5.0	5.0	Yes	Yes
35th Street to Harrison Boulevard/35th Street to Washington Way extension	4.9	4.9	Yes	Yes
35th Street to Harrison Boulevard/Behind fire station along Washington Way extension	5.1	5.1	Yes	Yes
35th Street to Harrison Boulevard/Campus Way to Washington Way extension	7.4	7.5	Yes	Yes
35th Street to Harrison Boulevard/Campus Way to west of OSU dairy farm	6.1	6.1	Yes	No
35th Street to Harrison Boulevard/west of OSU dairy farm to stream junction	5.1	5.1	Yes	No
35th Street to Harrison Boulevard/stream junction to Harrison Boulevard	5.4	5.4	Yes	No
Harrison Boulevard to Cardwell Hill Drive/upstream of junction with Walnut Boulevard Branch	5.3	5.2	Yes	No
Harrison Boulevard to Cardwell Hill Drive/downstream of Walnut Boulevard	4.7	4.7	Yes	Yes
Harrison Boulevard to Cardwell Hill Drive/Walnut Boulevard to Oak Creek Drive	5.8	5.8	Yes	NA
Harrison Boulevard to Cardwell Hill Drive/upstream of Oak Creek Drive	6.0	6.0	Yes	NA
Harrison Boulevard to Cardwell Hill Drive/downstream of Bald Hill Park entrance	4.6	4.6	Yes	NA
Harrison Boulevard to Cardwell Hill Drive/Bald Hill Park entrance to Ridgewood Drive	5.0	5.0	Yes	NA
Harrison Boulevard to Cardwell Hill Drive/Ridgewood Drive to Canyon Drive	7.5	7.5	Yes	NA
Walnut Boulevard Branch/ Along Walnut Boulevard near OSU Equestrian Center	4.8	4.8	NA	NA

NA – Not applicable; City staff or public input not provided for this location, usually limited to outside of city limits.

11.2.6 Stream Reach Summaries

For study purposes, Oak Creek was divided into a number of stream reaches based on the physical characteristics of the stream, property ownership, and other unique characteristics that would distinguish one section of the stream from the rest. The study findings are summarized in the following sections by reach description. Excerpts from the OSU Report are included. Public or City staff comments are noted as they were heard or provided, with minimal editing to preserve the context. If required, clarification is provided in parentheses.

Marys River to Highway 20/34

Public Comments: "Right below highway culvert on Oak Creek, water temperature was 70 degrees, too high. Took temperature on June 15, 1999."

OSU Report: Large amount of trash, broken concrete, and asphalt has been dumped into the lower reaches. The short section of the Oak Creek channel downstream of the highway culvert is incised and hydrologically disconnected from floodplain. The disconnection is a result of the deeply incised channel caused by a downcutting action of the creek. The deeper channel does not permit the frequent flooding (i.e., once every couple of years) of the floodplain surfaces as would normally occur in a healthy stream.

City Staff Reports: No comments provided for this reach.

Field Observations: Oak Creek downstream of Highway 20/34 has a narrow, confined functional floodplain. The overstory consists of oak, maple, and ash, with extensive blackberry thickets beneath. The stream habitat in this reach lacks diversity. The stream is almost completely composed of riffle habitat, consisting of a sinuous channel through a gravel streambed. The channel lacks large woody debris or other beneficial instream roughness structures.

A substantial obstacle to fish passage is located approximately 35 feet downstream of the twin box culverts under Highway 20/34. The concrete apron that extends about 20 feet downstream from the culverts is suspended 24 to 30 inches above the downstream streambed (12 to 18 inches above the water surface), with a residual low-flow pool. This structure represents an impassable barrier to fish under most flow conditions. Flow over the apron and through the highway culverts is extremely shallow during low-flow conditions, creating an additional barrier to fish passage.

Modeling Results: The model predicted no capacity problems in this reach. Velocities in the channel exceeded the 4 feet-per-second erosion criteria.

Highway 20/34 to Western Boulevard

Public Comments: "With new OSU hotel, will the drainage be addressed? Off parking lots?"

"Business on Morris Avenue (on north side of street) that backs up onto creek—could there be contamination issues (herbicides) or cleaning out tanks?"

OSU Report: The Oak Creek channel is incised and hydrologically disconnected from the floodplain. The overstory vegetation is oak and maple trees.

City Staff Reports: During the February 1996 flood, Western Boulevard was closed from Grove Street to 35th Street. High water was observed along Morris Avenue and on Grove Street, south of Western Boulevard.

Field Observations: The culverts beneath Highway 20/34 impound water, creating a long pool extending upstream past Morris Avenue. The banks in this reach are steep and covered by dense blackberry thickets that overhang the water surface. Also, a few clumps of native shrubbery, such as red osier dogwood, can be found in this reach. The channel width is roughly 20 feet, with the channel entrenched approximately 20 feet below the surrounding grade.

Concrete rubble was used to reinforce the lower banks and channel bottom several hundred feet upstream of Morris Avenue. Portions of the steep banks consist of old fill material. The outside (north) bank of the 90-degree bend near the Santana Court Apartment complex is bare and eroded. A recent effort to install erosion control fabric and native vegetation along the top of the steep bank does not appear to be working. The streambed has been scoured down to the bedrock of siltstone or mudstone.

The sinuous channel extending downstream of 30th Street is entrenched 15 to 20 feet below the prevailing grade. The banks are composed of silt. Steep slopes coupled with a sterile substrate and dense shade have resulted in relatively bare lower bank areas subject to scour erosion. Many of the streamside trees have suffered extensive root exposure due to scouring, making them prone to toppling. Once toppled, the trees are more likely to promote additional bank erosion in this reach than provide fish habitat since they often remain suspended above the confined low-flow channel. Instream, riffle and glide habitat predominate with a few small bedrock scour pools (some with submerged undercut ledges).

A stand of native trees, consisting predominantly of bigleaf maple, Oregon ash, Garry oak and red alder, is located in the vicinity of the bend. The stand continues relatively uninterrupted (except for road crossings) upstream beyond 35th Street. The trees provide good canopy cover and shade to the creek. Although bare slopes or blackberry-covered areas are common along the banks, some native snowberry, red osier dogwood, and Pacific ninebark shrubs provide limited cover.

Homemade bank revetments have been placed in a few areas between Western Boulevard and Morris Avenue. A few manmade dams composed of demolition rubble and basalt boulders are present in this area, although none appears to pose fish passage problems. A number of private water diversion structures were found. It is likely that most of these diversions do not have state water withdrawal permits. Some of the observed small boulder dams are used to facilitate water extraction.

Modeling Results: The model predicted no capacity problems in this reach. Velocities in the channel exceeded the 4 feet-per-second erosion criteria.

Western Boulevard to 35th Street

Public Comments: "The OSU parking lot in many areas encroaches onto the creek corridor and there is not an adequate buffer."

<u>OSU Report:</u> The Reser Stadium parking lot extends to the edge of the Oak Creek channel. During heavy rainfall, portions of the parking lot drain directly into the creek. A large amount of gravel from the parking lot has entered the creek, along with trash, broken concrete, and asphalt. Several low-rock check dams have been placed in the channel.

Along this reach of the stream, the university manages a variety of campus facilities, ranging from research laboratories to athletic fields and stadiums. The Forest Research Laboratory buildings and parking lot are immediately adjacent to Oak Creek. The Entomology Laboratory is located at 35^{th} Street. A chemical storage facility is located only a few feet from the upper bank of the creek.

The Oak Creek channel is incised and hydrologically disconnected from the floodplain. As with its other reaches, oak and maple trees make up the overstory vegetation. Significant amounts of riprap have been placed along the channel bank along with a sheet pile diversion structure (at the Entomology Laboratory). Past water withdrawals at the Entomology Laboratory were not permitted.

<u>City Staff Reports:</u> A few streets located away from the creek flooded during the February 1996 storm. High water was reported at the intersection of 35^{th} Street and Jackson Avenue. Orchard Avenue was closed from 35^{th} Street to just east of 30^{th} Street along with a small portion of 30^{th} Street.

<u>Field Observations:</u> Channel entrenchment varies from roughly 20 feet deep between Western Boulevard and 30^{th} Street to less than 10 feet deep near 35^{th} Street. Fill was placed along the left bank of Oak Creek to expand the parking area for Reser Stadium. It appears that fill was placed up to about the same level on the other side of the creek as well. The fill forms a steep slope roughly 6 to 8 feet high. Drainage from the stadium parking area has produced gullies along this slope.

Rock fill under the 30^{th} Street bridge has created an armored riffle habitat that encourages lateral bank erosion under high-flow conditions. The fill material appears to have created a long backwater pool in this relatively low-gradient reach. The rock accumulation does not appear to create an obstacle to fish passage.

A large-diameter pipe crosses the channel approximately 30 feet or so upstream of the 30^{th} Street bridge. The bottom of the pipe is only about 1 foot above the water surface under winter flow conditions. This pipe risks failure if a debris jam were to move downstream during a high-flow period and become lodged against it.

A steel dam is located about 250 feet downstream of the 35^{th} Street bridge. The dam has two spillways. The structure appears to be passable for larger fish under high-flow conditions, but would most likely constitute a barrier to the upstream migration of fish under lower flow conditions. A large gravel and sand bar has accumulated along the left bank downstream of 35^{th} Street, apparently due to the backwater affects of the dam.

The streambanks are over-steepened with vertical slopes in a few places. The banks consist of predominantly fine-grained material and non-engineered fills. A revetment composed of demolition debris is failing and exacerbating scour erosion. Some OSU facilities crowd the channel in the lower end of the reach. A number of stormwater pipes associated with the facilities extend out from the bank; without the benefit of energy-dissipating aprons, this can cause local bank erosion.

Canopy coverage is generally good throughout the reach, with a mix of overstory species similar to that downstream, although blackberry thickets are far more abundant here than in other reaches. Because of the over-steep banks, many of the trees rooted on the slopes are prone to scour and eventual toppling. Large fallen trees have accumulated in the channel several hundred feet upstream of 30th Street. Although they add structural diversity to the channel, they also encourage fluvial erosion and slumping because of the entrenched channel condition. The largest bank failure observed in this reach was located on the left bank about 700 feet downstream of the steel dam. The failed bank is about 75 feet long and 10 feet high. A large tree, still partially rooted on the lower bank, forms the downstream end of the failure zone. The tree is likely to promote further bank erosion in this immediate area.

Modeling Results: The piped systems along Campus Way, 30th Street, and 35th Street are over capacity according to the modeling results. The culvert where Campus Way crosses Oak Creek is extremely undersized, but was designed to operate as a ford. The model also shows overtopping of the Oak Creek channel near the OSU dairy. Velocities in the channel exceeded the 4 feet-per-second erosion criteria.

35th Street to Harrison Boulevard

Public Comments: "OSU has 2 cubic feet per second (cfs) water rights and they often irrigate during midday (12 – 2 p.m.)."

OSU Report: The University manages a large number of livestock in this reach. Poultry facilities are located north of Harrison Boulevard and east of 53rd Street. The facilities cover about 100 acres and contain 5,000 broilers. Manure is stored under a roof until spring or summer when it is spread over farm fields.

The campus dairy is located southeast of the poultry facilities, across Harrison Boulevard. The dairy operation covers 220 acres and houses 145 milk cows and 80 calves. Manure is flushed or scraped into a collection sump. There, a mechanical screen separates larger solids from the waste stream, and the solids are hauled away by a private contractor. During the winter, a 520,000-gallon storage tank stores about 70 days worth of liquid wastes before it is spread across farm fields.

A swine facility is located south of the Irish Bend covered bridge that crosses Oak Creek at Campus Way. The facility contains about 10 sows, and wastes are washed into a lagoon near the buildings. Once a year, during the summer, the lagoon is pumped and the accumulated wastes are applied to the fields.

Just west of 35th Street, 50 head of beef cattle are housed in a 30-acre facility. Most of the chip bedding for the animals is hauled away by a private contractor, with about 10 percent of the wastes spread on land north of the buildings.

Other activities within this reach include: an area for use by OSU military programs southwest of the EPA laboratory, a spoils area immediately west of the fire station on 35th Street, and a pop-up dam that allows 2 cfs of water withdrawals for irrigation during the summer.

The Oak Creek channel is incised and hydrologically disconnected from the floodplain. Gravel deposits are found upstream of the covered bridge and the low-water ford at Campus Way. Overstory vegetation is primarily oak and ash. Upstream of Campus Way, blackberry is the dominant understory vegetation.

City Staff Reports: City staff confirmed a number of flooding problems near OSU's Orchard Court housing complex (between 30th and 35th Streets). Some of the stormwater pipes are located beneath houses, making access difficult. In another instance, an outlet pipe in a manhole is at a higher elevation than the inlet pipe.

Field Observations: A small portion of Oak Creek upstream of 35th Street was investigated in the spring of 1998. The channel is incised about 15 feet upstream of the railroad right-of-way, along Washington Way. This reach contains the same general type of native deciduous tree canopy that was observed downstream (ash, oak, alder, bigleaf maple, cottonwood). Understory vegetation includes native species (rose, snowberry, red osier dogwood), in addition to areas of dense blackberry thickets and ivy. Much of this woody riparian vegetation has grown up through old manmade fills and revetments of demolition debris. Instream habitat complexity is generally far greater than found downstream of 35th Street. Habitat complexity is provided by apparently stable undercut tree roots and toppled large woody debris, including a few woody debris jams. Unfortunately, extensive dumping has significantly impacted the visual quality of the channel.

The rural area upstream of the main OSU campus appears to possess good water quality and surprisingly clean gravel areas that are potential fish spawning sites. Riparian canopy coverage is also generally good and the depth of entrenchment is usually much less than on the lower reaches of the stream within the urban area. A water diversion dam located just downstream of Harrison Boulevard appears to be an impassable fish barrier.

Modeling Results: Velocities in the channel exceeded the 4 feet-per-second criteria, indicating the potential for streambed or streambank erosion.

Walnut Boulevard Branch

Public Comments: No comments provided for this reach.

OSU Report: OSU operates the Equestrian Center along this tributary branch to Oak Creek. The Center is located north of Harrison Boulevard and 53rd Street. The facility houses 80 horses on 120 acres. Manure is hauled offsite during the winter, but during the summer the stall bedding is spread on the pastures. Llamas graze for the entire season. The overstory vegetation is predominantly willow.

City Staff Reports: No comments provided for this reach.

Field Observations: Field observations were not performed.

Modeling Results: The model predicted no capacity problems in this reach. Near the OSU Equestrian Center, velocities in the channel exceeded the 4 feet-per-second erosion criteria.

Harrison Boulevard to Cardwell Hill Drive

Public Comments: No comments provided for this reach.

OSU Report: The University manages the McDonald State Forest and the Wilson Sheep Farm in this reach. The sheep facility contains approximately 325 sheep on 300 acres where Oak Creek Drive crosses Oak Creek. Manure spreading and sheep access to the creek are concerns during the summer months. Long-term grazing may have led to formation of gullies. In the downstream area of this reach near Harrison Boulevard, the Oak Creek channel is incised and hydrologically disconnected from the floodplain.

City Staff Reports: No comments provided for this reach.

Field Observations: Only the lower section of this reach was observed. Several channels converge in a small wooded area between Harrison Boulevard and Walnut Boulevard. The main channel is slightly entrenched and has a standing pool of water during the summer from the irrigation dam operated by OSU downstream of Harrison Boulevard. (This section is shown on the National Wetland Inventory map). Another channel just to the north crosses under Walnut Boulevard. A small concrete apron creates an approximate 1-foot drop between the culvert and the water in the channel. A dense tangle of trees and shrubs occupies most of the channel and would likely restrict high flows through the channel. This area represents an opportunity for the construction of a regional detention or water quality facility.

Modeling Results: The model showed the culvert under Harrison Boulevard is undersized for the 10-year storm event. This restriction appears to cause flooding between Harrison and Walnut Boulevards where the northern tributary joins the main stem of Oak Creek. However, no buildings or other structures are threatened. The model also shows that the culvert at Walnut Boulevard is barely overtopped during the 10-year storm event (less than 0.1 cfs). Farther upstream, the model shows the channel is undersized below the entrance to Bald Hill Park. Velocities exceeded the 4 feet-per-second erosion criteria.

Cardwell Hill Drive to Headwaters

Public Comments: No comments provided for this reach.

City Staff Reports: No comments provided for this reach.

Field Observations: Field observations were not performed.

Modeling Results: The area defined by this reach and the other headwaters of the watershed were included in the hydrologic model to determine the quantity and distribution of stormwater runoff, but a hydraulic model was not constructed for this particular reach.

11.2.7 Watershed Summary

The headwaters of Oak Creek are located in the McDonald State Forest with over 70 percent of the watershed located within the forest. Downstream of the forest land, the land use changes to a mixture of agricultural and residential. Upon entering the City, the land use expands to include the OSU campus.

Within the City, the creek channel is incised and hydrologically disconnected from the overbank areas. Fish passage barriers exist at several locations as a result of manmade structures. In the lower reaches, the creek lacks habitat diversity, due in part to a lack of large woody debris and other beneficial structures. Canopy cover and the width of the riparian buffer vary considerably. The OSU Report states that water quality may be impacted by some existing agricultural practices, specifically manure spreading practices at the OSU dairy. Other OSU practices cited in the report that should be investigated include encroachment on the creek from development, water withdrawal, dams and barriers, stormwater drainage from the OSU campus, and toxic waste handling and storage practices.

11.3 WATERSHED MANAGEMENT OPTIONS

Recommendations for the Oak Creek watershed are shown in Table 11-3. The short-term options detailed in Table 11-4 include a wide range of activities, many of which will require cooperation with OSU. Many of the OSU Report recommendations focus on improving water quality and instream and riparian habitat. Some of the activities, such as tree plantings and the removal of non-native vegetation, could be performed by community groups as part of a stream stewardship program. Figure 11-4 shows the general locations of the short-term projects.

The long-term options shown in Table 11-5 include several capital improvement projects to enhance the channel and reduce the potential for bank erosion. Other activities include measures to improve fish passage at culverts and to improve instream water quality. Many of the recommendations will require a pre-design effort to determine the actual site, type, and size of facilities required to provide the desired results. Figure 11-5 shows the general locations of the long-term projects.

The computer modeling predicted high velocities throughout Oak Creek. The creek should be investigated to determine the exact locations where high velocities have eroded the stream banks. In these areas, a pre-design effort is required to determine the most appropriate type of streambank or channel improvement required to stabilize the bank to prevent further erosion. At several locations, fish passage issues were noted.

A large percentage of this watershed is owned and/or operated by OSU. The university has recognized that some of its activities may have an adverse impact on the creek. As a result, OSU has developed a plan for assessing six critical issues potentially impacting instream water quality and the condition of instream and riparian habitat (see Section 11.2.2). The City will want to coordinate with the university in this further assessment of Oak Creek. Equally important, the City will want to work with OSU in developing recommendations for this watershed. As identified in the OSU Report, the Oak Creek watershed represents an opportunity for teaching, research, demonstration sites, and public outreach. As with the other watersheds, many of the recommendations will require coordination with other government bodies, since much of it lies outside of the city limits or is regulated by state or federal agencies.

Table 11-3. Oak Creek Options

Reach	Abridged observations	Recommended activity	Priority
Marys River to Highway 20/34	1) Below the highway culvert, the water temperature was too high (70° F) on June 15, 1999.	a. Develop citywide requirements for minimum buffer widths.	Ongoing
		b. Plant trees for shade.	Short-term
		c. Develop conservation easements to protect existing stands of trees and riparian habitat.	Long-term
	2) Large amount of trash, broken concrete, and asphalt has been dumped in lower reaches.	a. Remove trash and debris without further impacting habitat.	Short-term
		b. Provide information to local landowners on acceptable stream stewardship practices.	Ongoing
	3) The channel lacks large woody debris or other beneficial instream roughness structures. Modeled velocities exceeded the 4-fps criteria at several locations.	a. In areas with erosion, anchor large logs in stream to channel high flow to center of stream to help prevent bank under cutting.	Long-term
	4) A fish passage obstacle is located 35 feet downstream of the twin box culverts under Highway 20/34.	a. Work with ODOT on fish passage issues.	Short-term
Highway 20/34 to Western Boulevard	1) How will the drainage and parking lot runoff from the new OSU hotel be addressed?	a. Coordinate with OSU on treatment requirements for stormwater runoff from parking lots.	Short-term
	2) Contamination issues may exist from a business on Morris Avenue.	a. City to inspect business for potential water quality related issues.	Short-term
		b. Develop citywide measures for improving quality of stormwater runoff from commercial facilities.	Ongoing
	3) The channel is incised and hydrologically disconnected from the floodplain.	a. Reconnect creek with floodplain by laying back stream banks allowing for more storage.	Long-term
	4) Flooding was observed during the February 1996 storm along Western Boulevard from Grove Street to 35th Street.	a. Work with local property owners to flood proof structures.	Long-term
	5) The culverts at Highway 20/34 impound water upstream past Morris Avenue.	a. Coordinate with ODOT on low-flow channel through culverts to provide better fish passage and to reduce water impoundment.	Long-term

Table 11-3. Oak Creek Options (continued)

Reach	Abridged observations	Recommended activity	Priority
	6) Dense blackberry thickets can be found on the steep banks.	a. Remove non-native vegetation and replant with native species.	Short-term
	7) Erosion control efforts along the north bank of the 90-degree bend near the Santana Court Apartment complex do not appear to be working. The steep slopes of the incised creek have tree roots that have been exposed and the trees are now prone to toppling.	a. Stabilize stream bank using vegetative techniques, if possible. Provide instream improvements to reduce potential for undercutting of stream banks.	Long-term
	8) A number of private diversion structures for water withdrawal were found.	a. Educate property owners in regards to legal water withdrawals. Coordinate with ODWR to provide enforcement if necessary.	Short-term
	9) Velocities exceeded the 4-fps criteria at several locations.	a. In areas with erosion, anchor large logs in stream to channel high flow to center of stream to help prevent bank under cutting.	Long-term
Western Boulevard to 35th Street	1) The parking lot at Reser Stadium encroaches on the creek corridor. Fill placed along the left bank of Oak Creek for the expansion of the Reser Stadium parking lot is experiencing erosion.	a. Establish a riparian buffer at Reser Stadium with parking lot set back from stream's edge. Stabilize the existing fill with vegetative plantings.	Long-term
	2) Portions of the parking lot at Reser Stadium drain directly into the creek. A large amount of gravel from the parking lot has entered the creek, along with trash, broken concrete, and asphalt.	a. Coordinate with OSU on treatment options for runoff from Reser Stadium parking lots.	Short-term
		b. Remove trash and debris without further impacting habitat.	Short-term
	3) A chemical storage facility is located only a few feet from the upper bank of the creek.	a. Work with OSU to have chemical storage facility removed from the flood plain.	Short-term
	4) The channel is incised and hydrologically disconnected from the floodplain.	a. Reconnect creek with floodplain by laying back stream banks upstream of 30th Street, allowing more storage.	Long-term
	5) The Entomology Laboratory has placed significant amounts of riprap along the channel bank, along with a sheet pile diversion structure for water withdrawals. Past water withdrawals at the Entomology Laboratory have not been permitted.	a. Remove diversion structure and find alternate source for water.	Short-term

Table 11-3. Oak Creek Options (continued)

Reach	Abridged observations	Recommended activity	Priority
	6) High water was reported at the intersection of 35th Street and Jackson Avenue during the February 1996 storm.	a. Work with local property owners to flood proof structures.	Long-term
	7) Rock fill under the 30th Street bridge is encouraging lateral bank erosion.	a. Stabilize streambank at 30th Street and provide for stream meander.	Long-term
	8) A large diameter pipe crossing the channel risks failure during high-flow events.	a. Evaluate existing pipe crossing upstream of 30th Street and determine if it is at risk. Provide upstream trash structure, if required by structural analysis of pipe.	Short-term
	9) The streambanks are overly steep and vertical in some locations. A revetment constructed from demolition debris is failing.	a. Stabilize stream bank using vegetative techniques, if possible. Provide instream improvements to reduce potential for undercutting of stream banks.	Long-term
	10) Stormwater pipes discharging into the creek do not have energy dissipation devices.	a. Provide energy dissipation structure and bank protection at locations of discharge pipes.	Short-term
	11) A large bank failure (75 feet long by 10 feet high) is located 700 feet downstream of the steel dam.	a. Stabilize stream bank downstream of steel dam using vegetative techniques, if possible. Provide instream improvements to reduce potential for undercutting of stream banks.	Long-term
	12) Stormwater piped systems along 30th and 35th Streets are under capacity for the design storm.	a. Replace undercapacity pipes near 30th and 35th Streets.	Short-term
	13) Velocities exceeded the 4-fps criteria at several locations.	a. In areas with erosion, anchor large logs in stream to channel high flow to center of stream to help prevent bank under cutting.	Long-term

Table 11-3. Oak Creek Options (continued)

Reach	Abridged observations	Recommended activity	Priority
35th Street to Harrison Boulevard	1) A number of OSU managed agricultural activities are conducted within this stream reach. Manure spreading may be contributing to water quality degradation.	a. Coordinate with OSU on agricultural management practices for dairy farm.	Short-term
	2) The channel is incised and hydrologically disconnected from the floodplain.	a. Reconnect creek with floodplain by widening stream and allowing for more storage upstream of Campus Way.	Long-term
	3) Blackberry is the dominant understory vegetation.	a. Coordinate with OSU on removal of non-native vegetation and replant with native species.	Short-term
	4) Extensive dumping in this area has significantly impacted the visual quality of the channel.	a. Remove trash and debris without further impacting habitat.	Short-term
	5) A water diversion dam located just downstream of Harrison Boulevard appears to be impassable by fish.	a. Coordinate with OSU on stopping stream withdrawals and finding other source for irrigation water. Remove diversion dam at Harrison Boulevard.	Short-term
	6) Instream water quality appears to be good upstream of the main OSU campus.	a. Work with OSU to develop stream buffers for protecting existing habitat and vegetation.	Long-term
	7) Velocities exceeded the 4-fps criteria at several locations.	a. In areas with erosion, anchor large logs in stream to channel high flow to center of stream to help prevent bank under cutting.	Long-term
	8) Crossing at Campus way is undersized.	a. Designed as a ford. No action required.	No action
	9) Pipe system near 35th Street is undersized.	a. Replace pipes as part of activity #12 in Western Boulevard to 35th Street stream reach.	Short-term
Walnut Boulevard Branch	1) Manure is spread over pasture lands during the summer at the OSU Equestrian Center.	a. Coordinate with OSU to determine acceptable agricultural management practices for Equestrian Center.	Short-term
	2) Velocities exceeded the 4-fps criteria at several locations.	a. Perform stream walk to look for evidence of erosion due to high velocities. In areas with erosion, anchor large logs in stream to channel high flow to center of stream to help prevent bank under cutting.	Long-term

Table 11-3. Oak Creek Options (continued)

Reach	Abridged observations	Recommended activity	Priority
Harrison Boulevard to Cardwell Hill Drive	1) OSU manages the McDonald State Forest.	a. Coordinate with OSU to determine acceptable forest management practices appropriate for headwaters.	Short-term
	2) OSU manages the Wilson Sheep Ranch. Manure is spread over pasture lands during summer months.	a. Coordinate with OSU to determine acceptable agricultural management practices for sheep ranch.	Short-term
	3) The channel is incised and hydrologically disconnected from the floodplain near Harrison Boulevard.	a. Reconnect creek with floodplain by laying back stream banks allowing for more storage.	Long-term
	4) The area near the creek crossing of Walnut represents the potential for a detention or water quality facility.	a. Investigate potential for constructing a multi-objective facility at this location.	Long-term
	5) Velocities exceeded the 4-fps criteria at several locations.	a. Perform stream walk to look for evidence of erosion due to high velocities. In areas with erosion, anchor large logs in stream to channel high flow to center of stream to help prevent bank under cutting.	Long-term
	6) Culvert under Harrison Boulevard is undersized.	a. There are no reports of flooding problems, so replacement is not recommended.	No action
	7) Undersized channel downstream of Oak Creek Drive crossing.	a. There are no reports of flooding problems, so further action is not recommended.	No action
	8) Undersized channel on agricultural land to east of Bald Hill.	a. There are no reports of flooding problems, so further action is not recommended.	No action
	9) Undersized channel at entrance to Bald Hill.	a. There are no reports of flooding problems, so further action is not recommended.	No action

Table 11-4. Oak Creek Short-Term Program

Reach	Recommended activity	Capital cost ($)	Annual O&M ($)	Project type[1]
Marys River to Highway 20/34	1) Plant trees for shade.	800	40	Orange line
	2) Remove trash and debris without further impacting habitat.	400	20	
	4) Work with ODOT on fish passage issues.	400	NA	
Highway 20/34 to Western Boulevard	1) Coordinate with OSU on treatment requirements for stormwater runoff from parking lots.	800	NA	
	2) City to inspect business along Morris Avenue for potential water quality related issues.	200	NA	
	6) Remove non-native vegetation and replant with native species.	9,000	450	
	8) Provide information to educate property owners in regards to legal water withdrawals. Coordinate with ODWR to provide enforcement if necessary.	600	NA	
Western Boulevard to 35th Street	2) Coordinate with OSU on treatment options for runoff from Reser Stadium parking lots.	1,200	NA	
	2) Remove trash and debris without further impacting habitat.	4,000	200	
	3) Work with OSU to have chemical storage facility removed from the flood plain.	200	NA	
	5) Remove diversion structure at Entomology Laboratory and find alternate source for water.	1,200	NA	
	8) Evaluate existing pipe crossing upstream of 30th Street and determine if it is at risk. Provide trash structure if necessary.	2,100	NA	
	10) Provide energy dissipation structure and bank protection at locations of discharge pipes at Reser Stadium.	2,500	125	
	12) Replace under-capacity pipes near 30th and 35th Streets, including those that flow into the 35th Street to Harrison Boulevard stream reach.	400,000	NA	Red line
35th Street to Harrison Boulevard	1) Coordinate with OSU on agricultural management practices for dairy farm.	200	NA	
	3) Coordinate with OSU on removal of non-native vegetation and replant with native species.	200	NA	

Table 11-4. Oak Creek Short-term Program (continued)

Reach	Recommended activity	Capital cost ($)	Annual O&M ($)	Project type[1]
	4) Remove trash and debris without further impacting habitat.	8,250	NA	
	5) Coordinate with OSU on removing diversion dam at Harrison Boulevard, stopping stream withdrawals, and finding other source for irrigation water.	2,400	NA	
	9) Replace undersized pipes near 35th and 30th Streets. (See #12 in Western Boulevard to 35th Street reach.)	See #12 above	See #12 above	See #12 above
Walnut Boulevard Branch	1) Coordinate with OSU to determine acceptable agricultural management practices for Equestrian Center.	200	NA	
Harrison Boulevard to Cardwell Hill Drive	1) Coordinate with OSU to determine acceptable forest management practices appropriate for headwaters.	400	NA	
	2) Coordinate with OSU to determine acceptable agricultural management practices for sheep ranch.	200	NA	
Total		**435,250**	**835**	

[1]Project types are in the Figure 11-4 map legend.

Table 11-5. Oak Creek Long-Term Program

Reach	Recommended activity	Capital cost ($)	Annual O&M ($)	Project type[1]
Marys River to Highway 20/34	1) Develop conservation easements to protect existing stands of trees and riparian habitat.	NA	NA	
	3) Anchor large, woody debris to slow flows, decrease erosion and provide more varied habitat.	8,000	400	
Highway 20/34 to Western Boulevard	3) Reconnect creek with floodplain and allow for more storage.	80,000	4,000	
	4) Work with local property owners to flood proof structures (homes, businesses, etc.) if they were inundated during the February 1996 storm.	225,000	NA	
	5) Coordinate with ODOT on low-flow channel through culverts to provide better fish passage and to reduce water impoundment, if possible.	800	NA	
	7) Stabilize streambank using vegetative techniques, if possible. Provide instream improvements to reduce potential for undercutting of streambanks.	7,000	350	Green line
	9) In areas with erosion, anchor large logs in stream to channel high flow to center of stream to help prevent bank under cutting.	12,000	600	
Western Boulevard to 35th Street	1) Establish a riparian buffer near Reser Stadium with parking lot set back from stream's edge. Stabilize fill with vegetative plantings.	2,400	120	
	4) Reconnect creek with floodplain by allowing for more storage upstream of 30th Street.	100,000	5,000	Yellow line
	6) Work with local property owners to flood proof structures.	150,000	NA	
	7) Stabilize streambank at 30th Street with and provide for stream meander.	14,000	700	Green line
	9) Stabilize streambank using vegetative techniques, if possible. Provide instream improvements to reduce potential for undercutting of streambanks.	7,000	350	Green line
	11) Stabilize streambank downstream of steel dam using vegetative techniques, if possible. Provide instream improvements to reduce potential for undercutting of streambanks.	7,000	350	Green line

Table 11-5. Oak Creek Long-term Program (continued)

Reach	Recommended activity	Capital cost ($)	Annual O&M ($)	Project type[1]
	13) In areas with erosion, anchor large logs in stream to channel high flow to center of stream to help prevent bank under cutting.	16,000	800	
35th Street to Harrison Boulevard	2) Reconnect creek with floodplain allowing for more storage upstream of Campus Way.	4,000	NA	Yellow line
	6) Work with OSU to develop stream buffers for protecting existing habitat and vegetation.	800	NA	
	7) In areas with erosion, anchor large logs in stream to channel high flow to center of stream to help prevent bank under cutting.	24,000	1,200	
Walnut Boulevard Branch	2) Perform stream walk to look for evidence of erosion due to high velocities. In areas with erosion, anchor large logs in stream to channel high flow to center of stream to help prevent bank under cutting.	100	NA	☑
Harrison Boulevard to Cardwell Hill Drive	3) Reconnect creek with floodplain by allowing for more storage.	100,000	5,000	Yellow line
	4) Investigate potential for constructing a multi-objective facility at this location.	40,000	2,000	
	5) Perform stream walk to look for evidence of erosion due to high velocities. In areas with erosion, anchor large logs in stream to channel high flow to center of stream to help prevent bank under cutting.	400	NA	☑
Total		**798,500**	**20,870**	

[1]Project types are in the Figure 11-5 map legend.

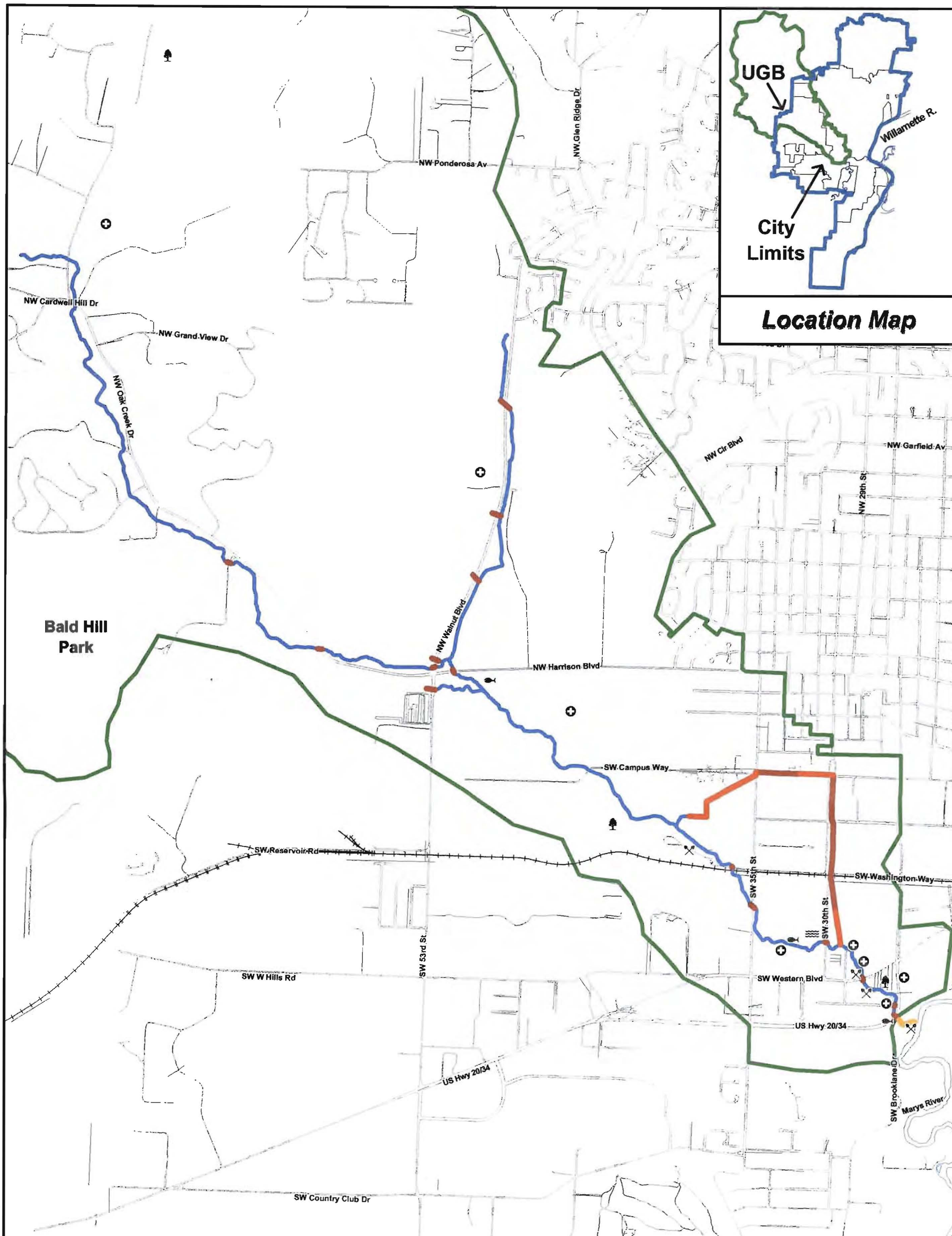


Figure 11-4 Short Term Project Locations

LEGEND

- Pipes/Bridges
- Channels
- Basin Boundary
- Bank Stabilization
- Canopy Revegetation
- Channel Improvement
- Replace Pipe/Bridge
- Fish Passage
- Buffer/Riparian Habitat
- Floodplain Reconnection
- Water Quality BMP
- Flood BMP
- Maintenance
- Monitor
- Multi-Use Facility

N

Feet 600 0 600 1200 1800 2400 Feet

CORVALLIS ENHANCING COMMUNITY LIVABILITY Public Works Department

BROWN AND CALDWELL and Associated Firms

report/figures/final/Fig11-4.wor, November 6, 2000, base data from City of Corvallis GIS Department

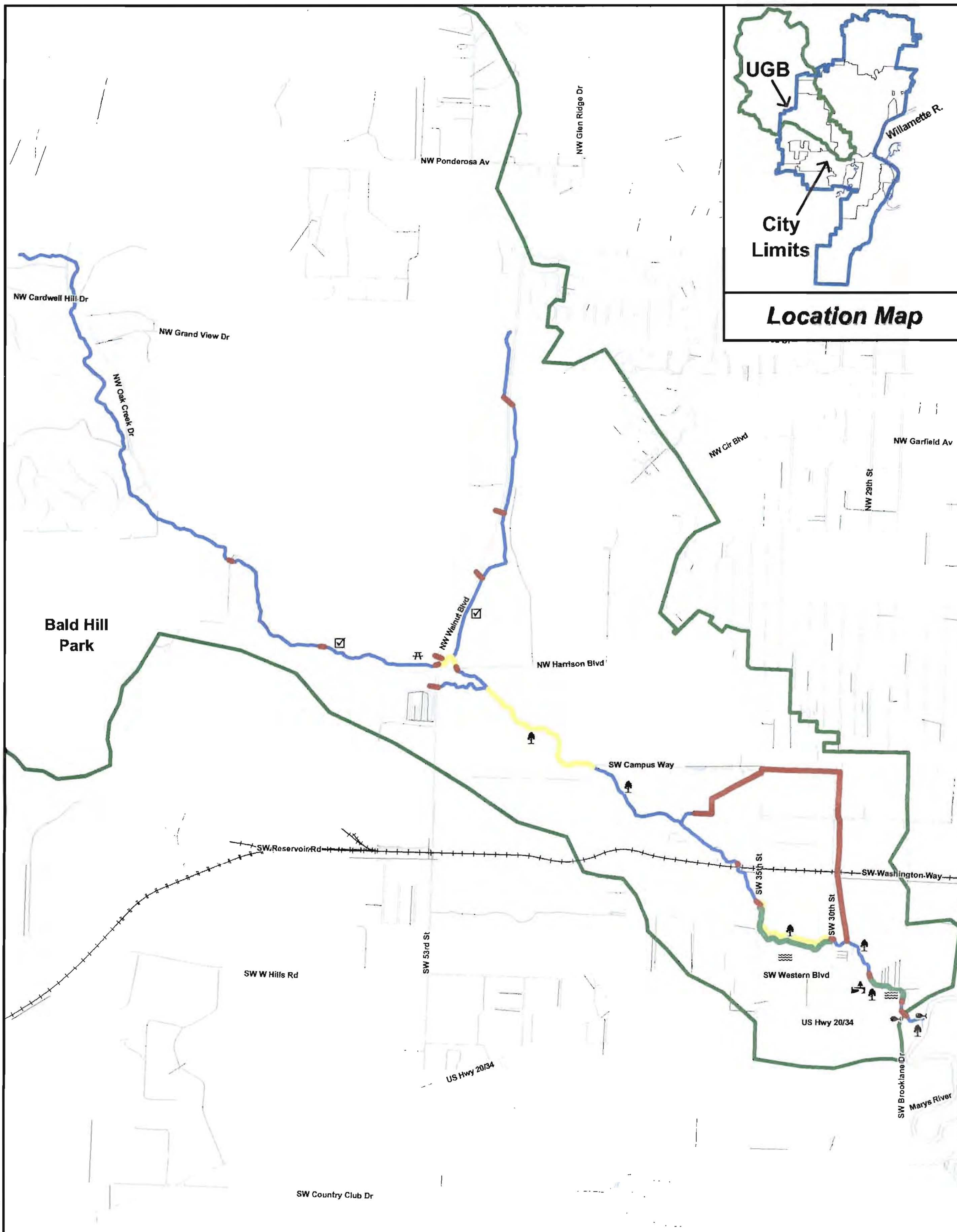


Figure 11-5 Long Term Project Locations

LEGEND

- Pipes/Bridges
- Channels
- Basin Boundary
- Bank Stabilization
- Canopy Revegetation
- Channel Improvement
- Replace Pipe/Bridge
- Fish Passage
- Buffer/Riparian Habitat
- Floodplain Reconnection
- Water Quality BMP
- Flood BMP
- Maintenance
- Monitor
- Multi-Use Facility

N

Feet 600 0 600 1200 1800 2400 Feet

CORVALLIS Public Works Department

BROWN AND CALDWELL and Associated Firms

report/figures/final/Fig11-5.wor, November 6, 2000, base data from City of Corvallis GIS Department

CHAPTER 12

WATERSHED PLANNING AND ANALYSIS: MARYS RIVER

12.1 INTRODUCTION

The Marys River watershed contains three small drainages that lie south of the Corvallis Country Club. The drainages are outside the city limits, but inside the Urban Growth Boundary (UGB). Flows from the drainages run southward underneath Brooklane Drive before entering the Marys River floodplain. The 78 acres of the drainages were modeled from the culverts underneath Brooklane Drive to the top of their drainages at the crest of the hill. The existing land use is split between low-density residential and open space, although the area is undergoing significant development. In the future, low-density residential will cover 69 acres, with the rest preserved with an open-space conservation designation.

12.2 WATERSHED FINDINGS

Information on watershed conditions was obtained by collecting public comments at open houses, working with City staff to identify maintenance and operation problems, conducting a technical stream evaluation of selected reaches, and by modeling the conveyance system for the existing and future build-out scenarios. This information is summarized in Section 12.2.5. A map of the Marys River watershed, presented as Figure 12-1, shows the location of the drainages within the UGB and identifies some of the major observations made during the watershed study.

All three Marys River drainages that were studied have moderate slopes upstream of Brooklane Drive, as shown in Figure 12-2, Photo 1. The central and western drainages become flatter downstream of the culvert. The eastern drainage contains a short, steep section of channel downstream of the culvert before it reaches the flatter floodplain.

The Marys River drainages are currently undergoing significant development. As shown in Figure 12-2, Photos 2 and 3, this development will add considerable impervious area to what has previously been open space and a limited number of homes on large lots. The three culverts examined did not appear to have capacity problems, but the east culvert (Figure 12-2, Photo 4) has a steep slope. The steep slope leads to high velocities, which has caused erosion problems downstream of the culvert in spite of a flow dissipater at the culverts downstream end (Figure 12-2, Photo 5). Problems with erosion have also led to the installation of extensive riprap in the Park Estates development occurring farther to the east at the bottom of the slope (Figure 12-2, Photo 6).

12.2.1 Public Comments

Public meetings were held to encourage and facilitate public input into the planning process. The first of the meetings for the Oak Creek, Marys River, and South Corvallis watersheds was held on June 17, 1999 at the LaSells Stewart Center. During that meeting and a subsequent meeting, on September 30, 1999, residents were encouraged to share their knowledge of problem areas and to identify opportunities for improving the health of the Marys River watershed. A number of general comments related to the Marys River were received at the two meetings and are presented below. Reach-specific comments are presented in Section 12.2.5.

- "Have seen filamentous algae blooms in the Marys River."
- "Does Corvallis monitor for water quality?"
- "Marys River Watershed Council has been monitoring temperature and are trying to find money to monitor contaminants."
- "It isn't a good place to be when we (City) are not monitoring for water quality parameters because it is expensive. We need that information if there are benchmarks for stormwater."
- "Is there documentation of lower Marys River for historical water temperature (100-150 years)? 64 degrees is the target—is that doable?"
- "Another parameter in the Marys River being looked at is flow modification."
- "Seeing pulses of sediment coming down Marys River is disturbing."
- "Since Marys River watershed is pretty much in Benton County, the County could be the jurisdiction to manage the watershed."
- "The City needs to consider how to fund and monitor water quality in the Stormwater Master Plan. If it is a staffing or funding issue, etc., we need to look at this need—a capital program for funds."
- "The City monitors water at one spot on Marys River for limited parameters. We also sample at the downstream end of creeks, but do not check for water quality parameters like pesticides."

12.2.2 City Staff Reports

City Engineering and Utilities Operations staff is familiar with most of the Marys River watershed largely through review of development plans. They provided input into the planning process by identifying known problem areas, recommending areas for stream enhancement activities, and recounting the extent and duration of flooding during major storm events, such as the February 1996 storm.

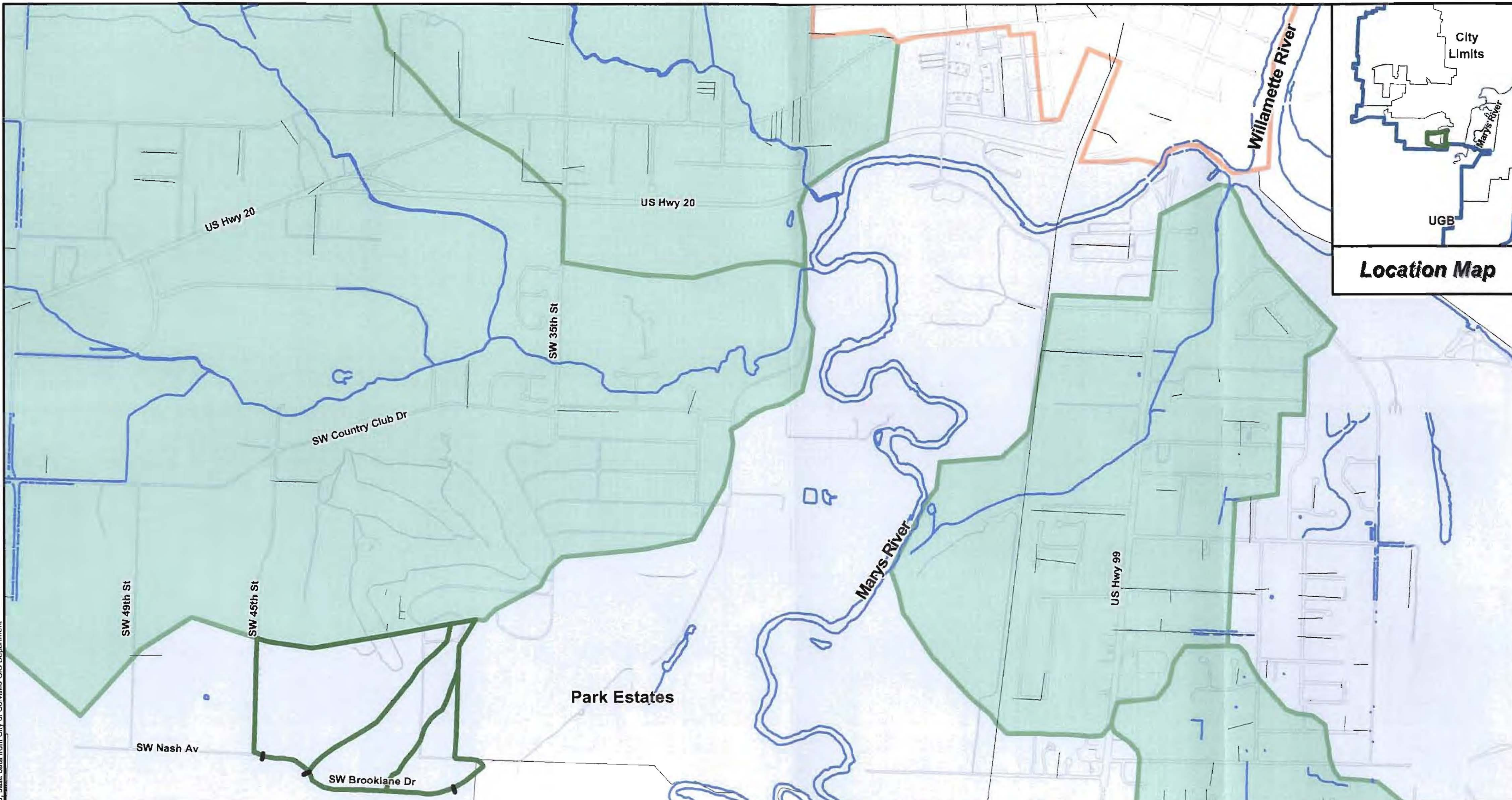


Figure 12-1 Marys River Watershed

LEGEND

Urban Growth Area

Combined Basin Area

Stormwater Basin Area

Study Basin Boundary

Culverts

N

CORVALLIS Public Works Department

BROWN AND CALDWELL and Associated Firms

November 10, 2000, base data from City of Corvallis GIS Department

Figure 12-2. Watershed Photos

Photo 1. Uphill from middle culvert at Brooklane Drive

Photo 2. Marys River area is developing rapidly

Photo 3. Uphill from east culvert, line of new culvert under Brooklane Drive

Photo 4. Entrance to east culvert in private yard

Photo 5. Erosion at east culvert outlet

Photo 6. Park Estates ditch with riprap

12.2.3 Field Study Observations

No detailed field investigations were conducted for the Marys River watershed. A limited amount of information was collected in August 2000 as part of data gathering for the culvert analysis.

12.2.4 Modeling Results

A computer model for the Marys River watershed identified the hydraulic capacity and projected flows in the culverts of the conveyance system for existing and future build-out scenarios. Existing conditions are based on watershed conditions before the current development, which began during the summer of 2000. Future conditions are based on full development (build-out) of the watershed as identified in the City's Comprehensive Plan. A full range of storms was modeled for the existing and future scenarios, including the 2-, 10-, 25-, and 100-year storm events. None of the three culverts modeled are undersized for the City's 10-year design storm. A complete summary of all modeled segments is provided in Appendix C.

The hydrologic/hydraulic model also estimated flow velocities in channel segments to determine areas at risk for channel or streambank erosion. Velocities in excess of 4 feet per second (fps) may cause erosion of the streambank or streambed. The model predicted velocities based on the 2-year storm event—the storm size most responsible for determining the channel configuration. The velocities below the eastern culvert were estimated as about 5 feet per second, enough to cause the erosion observed in the downstream channel.

Table 12-1. Modeled Velocities for Marys River Basin, Channel Segments Exceeding 4 feet per second

Reach/Model segment	2-year storm		Erosion observed	Existing bank stabilization
	Existing velocities	Future velocities		
Eastern culvert	5.1	5.1	Yes	Yes

12.2.5 Reach Summaries

For study purposes, Marys River was divided into several drainages, each flowing to a single culvert. For consistency with the other chapters of this SWMP, each drainage is referred to as a reach, even though the reaches do not join each other within the study area. The study findings are summarized in the following sections by reach description. Public comments are noted as they were recorded or as provided from various sources, with minimal editing.

<u>**West Basin**</u>

<u>Public Comments:</u> "What are ideas and plans for the development process to regulate their impacts such as silt during development? Bales that are clearly not doing the job? Example at Country Club and 49th."

"Should developer pay (through development fees or fines) for erosion control program?"

"If put responsibility on owner—outcome-based approach (Senate Bill 1010). Give a land owner the freedom to find a way to achieve an objective, but then have City check-up."

City Staff Reports: No staff reports were available for this reach.

Field Observations: Most of this reach is undergoing development. Future conditions call for housing to fill most of the drainage area, with the exception of some open space left for conservation purposes near the ridgeline. Development will result in substantial increases in impervious areas, flows, and pollutants from this reach. A new 30-inch culvert is being installed under Brooklane Drive to handle flows from the development. Slopes level out by the culvert.

Modeling Results: Modeling showed no capacity problems for the 10-year storm event. Velocities during the 2-year storm event did not exceed the 4 feet-per-second criteria.

Central Basin

Public Comments: No public comments were available for this reach.

City Staff Reports: No staff reports were available for this reach.

Field Observations: The central basin contains single-family homes on large, wooded lots leading down to an agricultural meadow and the culvert under Brooklane Drive. The slope levels out by the culvert. The basin will see some additional development and imperviousness in the future.

Modeling Results: Modeling showed no capacity problems for the 10-year storm event. Velocities during the 2-year storm event did not exceed the 4 feet-per-second criteria.

East Basin

Public Comments: During the field inspection of the culverts, a property owner was concerned about City plans for the area. A week or two previously, she had noticed some people looking around the neighborhood and the next thing she knew there was a crane and other heavy equipment installing new pipe.

City Staff Reports: The intersection of Agate Avenue and Fairmont Drive was closed during the February 1996 storm due to high water.

Field Observations: The main path for stormwater runs through a private yard and enters a culvert under Brooklane Drive. The culvert has a steep grade, resulting in high velocity discharges. A small concrete wall has been incorporated into the culvert apron at its downstream end to dissipate the force of the flow. However, soil is eroding underneath the culvert apron and in the downstream channel.

Modeling Results: Modeling showed no capacity problems for the 10-year storm event. However, the steep culvert discharges high velocity flows, estimated at 5 feet-per-second during the 2-year storm event, causing erosion downstream.

Park Estates Basin

Public Comments: No public comments were available for this reach.

City Staff Reports: City staff reported that the piped system for this development discharges to a pond prior to entering the Marys River.

Field Observations: The Park Estates development is located at the base of the slope below Oak Lawn Memorial Park. A culvert, apparently from the cemetery, discharges to a riprap-lined ditch before entering the pipe system. Most of the development has a moderate to flat slope.

Modeling Results: The Park Estates development was not modeled.

12.3 WATERSHED MANAGEMENT OPTIONS

Recommendations for the Marys River watershed are shown in Table 12-2. Recommended options include extending the steep culvert in the east basin to prevent erosion, conducting effective inspection and enforcement of erosion control plans, and coordinating with the Marys River Watershed Council to improve watershed health throughout the Marys River drainage.

All of the recommendations for the Marys River watershed were assigned to the short-term program listed in Table 12-3. Figure 12-3 shows the general locations of the short-term projects.

Table 12-2. Marys River Options

Reach	Abridged observations	Recommended activity	Timing
West Basin	1) Concern about erosion on construction projects.	a. Develop citywide requirements for erosion and sediment controls.	Ongoing
	2) Increased imperviousness due to development.	a. Preserve vegetated channel system through conservation easements to mitigate effects of increased flows and pollutants.	Short-term
		b. Encourage participation in Watershed Stewardship Education Program (Marys River Watershed Council) by property owners.	Ongoing
Central Basin	1) Increased imperviousness due to development.	a. Preserve vegetated channel system through conservation easements to mitigate effects of increased flows and pollutants.	Short-term
		b. Encourage participation in Watershed Stewardship Education Program (Marys River Watershed Council) by property owners.	Ongoing
East Basin	1) Lack of information about plans for neighborhood.	a. Provide information as part of adoption of stormwater master plan.	Ongoing
	2) Flooding at Agate Avenue and Fairmont Drive.	a. Keep conveyance system clean of debris to prevent flooding due to blockages.	Short-term
		b. Survey and engineering analysis to analyze conveyance system (culvert) in area.	Short-term
	3) High velocity discharges causing erosion downstream of culvert.	a. Extend culvert to flatter area (approximately 100 feet) and install large flow dissipater at this point.	Short-term
Park Estates Basin	1) Increased imperviousness due to development.	a. Preserve vegetated channel system through conservation easements to mitigate effects of increased flows and pollutants.	Short-term
		b. Encourage participation in Watershed Stewardship Education Program (Marys River Watershed Council) by property owners.	Ongoing

Table 12-3. Marys River Short-Term Program

Reach	Recommended activity	Capital cost ($)	Annual O&M ($)	Project type[1]
West Basin	2) Preserve vegetated channel through conservation easements to mitigate effects of development.	2,000	275	
Central Basin	1) Preserve vegetated channel through conservation easements to mitigate effects of development.	2,000	275	
East Basin	2) Clean debris from Agate Avenue and Fairmont Drive.	NA	1,000	
	2) Survey and engineering analysis to analyze conveyance system (culvert) in area.	600	NA	☑
	3) Extend culvert and install large flow dissipater.	25,000	NA	Green line
Park Estates Basin	1) Preserve vegetated channel through conservation easements to mitigate effects of development.	2,000	275	
Total		**31,600**	**1,825**	

[1]Project types are in the Figure 12-3 map legend.

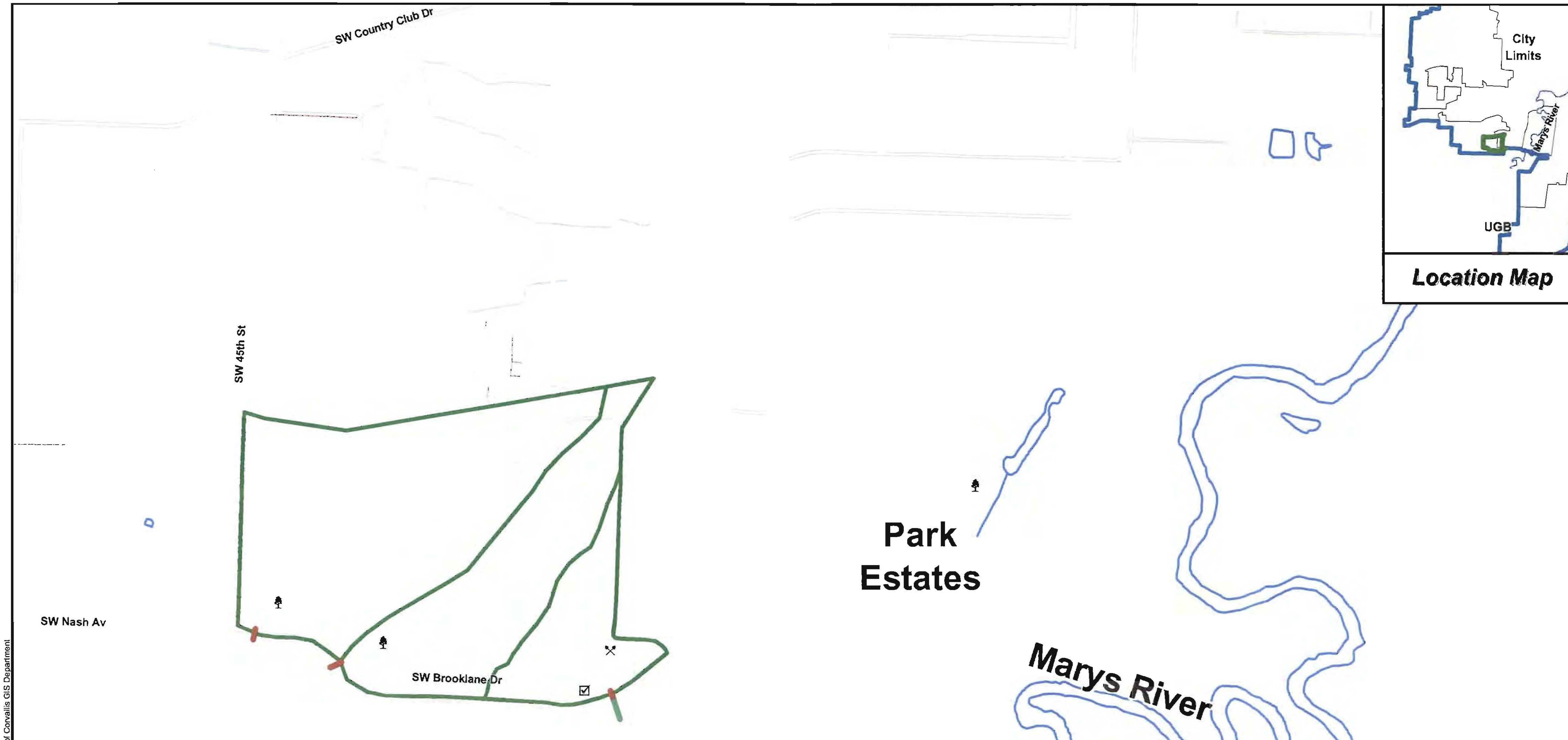
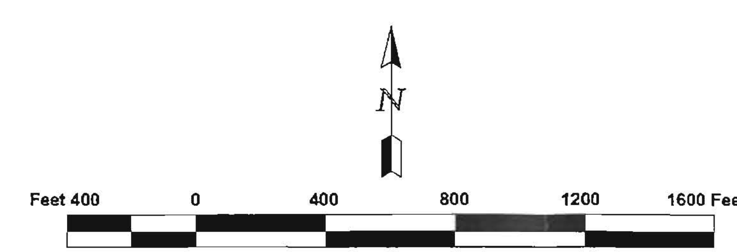


Figure 12-3 Short Term Project Locations

LEGEND

- Pipes/Bridges
- Bank Stabilization
- Replace Pipe/Bridge
- Canopy Revegetation
- Channels
- Basin Boundary
- Channel Improvement
- Fish Passage
- Floodplain Reconnection
- Maintenance
- Flood BMP
- Buffer/Riparian Habitat
- Water Quality BMP
- Monitor
- Multi-Use Facility



CORVALLIS Public Works Department

BROWN AND CALDWELL and Associated Firms

...ror, November 15, 2000; base data from City of Corvallis GIS Department

CHAPTER 13

WATERSHED PLANNING AND ANALYSIS: SOUTH CORVALLIS

13.1 INTRODUCTION

The South Corvallis watershed lies on either side of Highway 99, south of the Marys River. It is flat with poorly drained soils, reflecting the area's origins as alluvial terraces formed by the Willamette River. The watershed's lack of topographic relief—most slopes have a less than 2 percent gradient—has resulted in a series of small, unconnected drainage basins. Areas west of Highway 99 drain to Marys River, while areas east of Highway 99 drain to Booneville Slough and the Willamette River.

South Corvallis has a long history of flooding problems, most recently in February 1996, as shown in Figure 13-2, Photo 1. The South Corvallis Drainage Master Plan (SCDMP) was completed in 1996 (KCM, 1998). The study area for the SCDMP focused on the areas south of Goodnight Avenue. The SCDMP reported the existing land uses to be mainly farming, with future uses focused on light industrial. The existing airport land use will remain as airport land in the future.

Two drainage basins were examined to provide recommendations for areas not addressed by the SCDMP: Mill Race and Goodnight Avenue. The 350-acre Mill Race drainage basin presently contains a mixture of residential, industrial, and undeveloped property. The City's Comprehensive Plan zoning indicates that, in the future, undeveloped property will be converted to commercial use with some areas reserved as open space.

Existing land use in the 300 acres of the Goodnight Avenue drainage basin consists mainly of residential and undeveloped properties. This area is expected to be developed almost completely as residential and at a somewhat higher density than at present. A portion of this basin overlaps with the SCDMP, specifically the area to the south of Goodnight Avenue. The focus of the SWMP is on the piped system in Goodnight Avenue. The recommendations provided in the SCDMP were assumed to be implemented for the future scenario.

Several smaller areas in South Corvallis that are within the Urban Growth Boundary (UGB) and that drain directly to the Willamette or Marys River were considered to be small basins that did not require detailed modeling or recommendations. Flooding and drainage characteristics in these basins are typically a function of flooding of the Willamette and Marys Rivers. Ryan Creek is an example of one of these small basins. This seasonal creek is an established drainageway with sufficient capacity based on the 1981 Corvallis Drainage Master Plan. The seasonal creeks associated with these smaller basins should be managed based on the policy recommendations for Uplands Natural Resources and Stream System policy sections in Chapter 5.

13.2 WATERSHED FINDINGS

Input on watershed conditions was obtained by collecting public comments at open houses, working with City staff to identify maintenance and operation problems, and by modeling the conveyance system for existing and future build-out scenarios. This information was compiled for the two drainage basins mentioned above. A map of the South Corvallis watershed, shown in Figure 13-1, identifies the location of the basins within the UGB and identifies some of the major observations made during the watershed study.

Both drainage basins are flat, as is the rest of South Corvallis. A portion of the Goodnight Avenue drainage basin is served by a piped collection system with a small detention pond incorporated into the system, as shown in Figure 13-2, Photo 2. A manmade wetland is located to the south between Goodnight Avenue and Centerpointe Drive. New development to the east and south will add considerable impervious area to what has previously been open space, and will also require expansion of the area's drainage system to handle the resulting increased flows. Assuming SCDMP improvements are made, one section of pipe in Goodnight Avenue would still be undersized for the 10-year storm event. If the SCDMP improvements are not made, the system is overloaded by runoff from the currently undeveloped properties. City Flood Mitigation Projects (1999 and 2000) have attempted to reduce the flooding potential and extent by improving elements of the surface drainage system. These minor improvements have helped drainage in the area; however, the area's chronic flooding will have to be addressed by the SCDMP's recommendations.

The Mill Race drainage basin is a relatively large channel connecting Marys River to the Willamette River. Flooding has been reported on numerous occasions when the Marys and Willamette Rivers are in flood stage and flows overrun the channel. Analysis shows that flooding is not caused by local drainage, although erosion of the channel and banks is a common water quality problem.

Most of the stream reaches have a tree canopy that provides shade. The downstream reach of the Mill Race drainage basin lacks a tree canopy, but does contain numerous small willows that limit channel erosion, as shown in Figure 13-2, Photo 3. The reaches farther upstream have better shade but more problems with channel erosion. During summer months, water in the channel is not hydrologically connected to either the Willamette or the Marys Rivers. The reaches have alternate sections of dry channel, as shown in Figure 13-2, Photo 4, with stagnant pools of water, as shown in Figure 13-2, Photo 5. The upstream end of the Mill Race drainage basin has large trees for shade and woody debris in the channel. It also has erosion problems and a culvert that is almost completely filled in with sediment, as shown in Figure 13-2, Photo 6.

The problem areas identified in the following sections are shown in Figure 13-3.

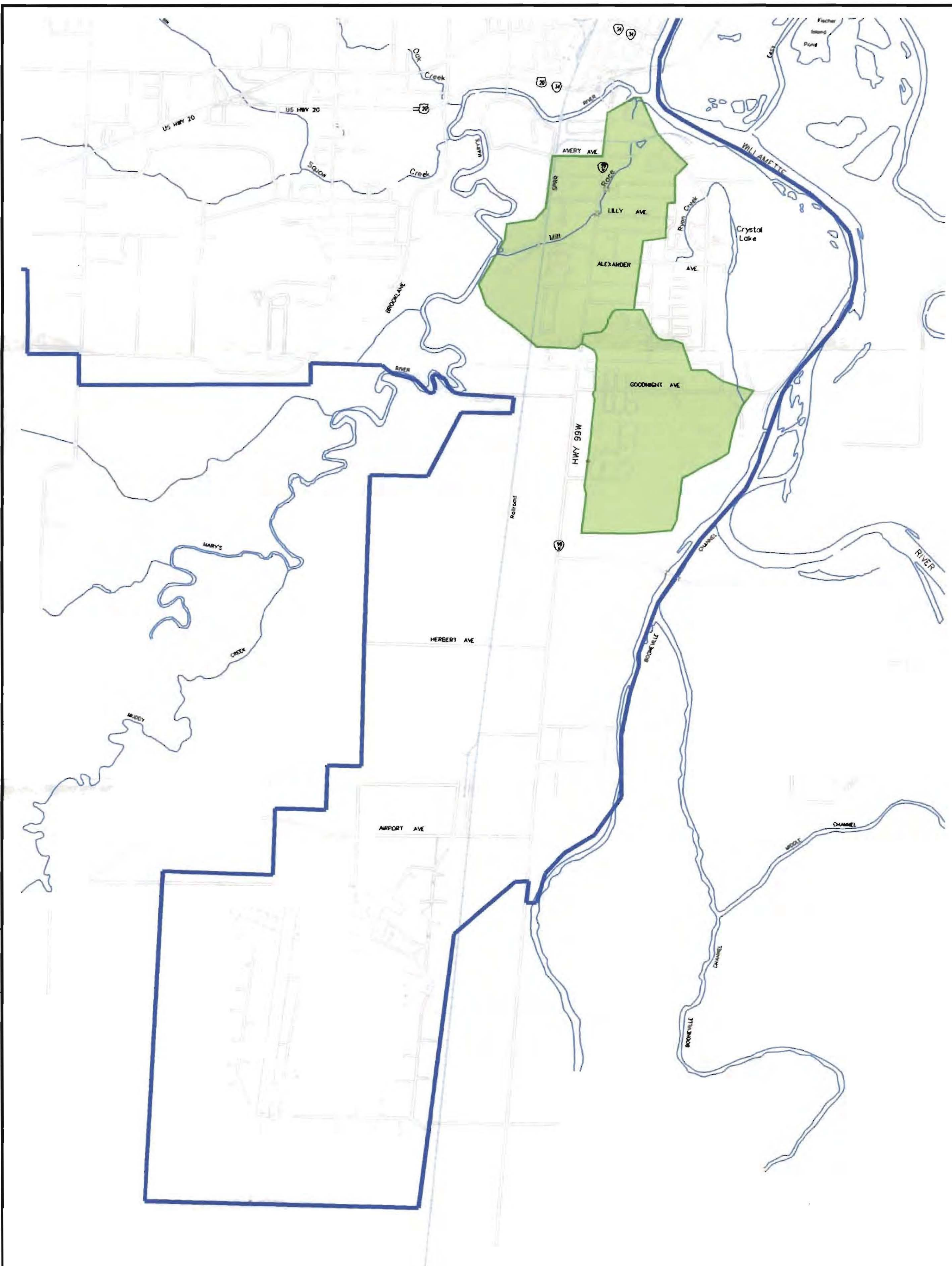


Figure 13-1 South Corvallis Study Areas

LEGEND

Urban Growth Area

Study Basins

N

Mile 1/4 0 1/4 1/2 3/4 1 Mile

CORVALLIS
Public Works Department

ACAD File: X:\Dept-Wide Projects\Master Plans\Storm Water\SWMP\DWG\new fig 13-1.dwg

Figure 13-2. Watershed Photos

Photo 1. 1996 flooding in Avery Park.

Photo 2. Detention pond near Goodnight Avenue.

Photo 3. Channel upstream of Crystal Lake Drive.

Photo 4. Channel upstream of Atwood Avenue.

Photo 5. Stagnant water in the Mill Race upstream of Hwy 99.

Photo 6. Culvert at Allen Street filled with sediment.

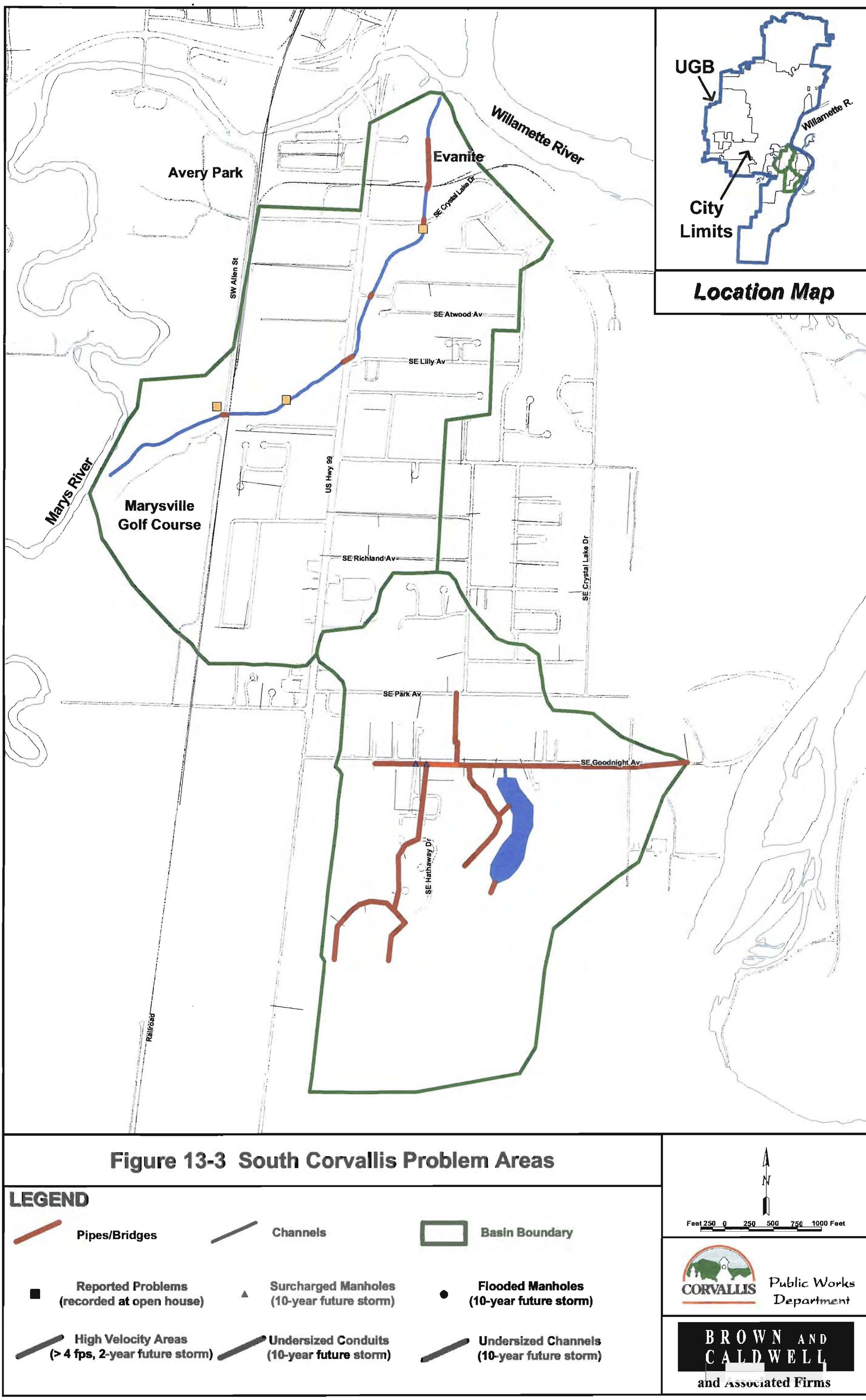


Figure 13-3 South Corvallis Problem Areas

report/figures/final/Fig13-3.wor, November 10, 2000, base data from City of Corvallis GIS Department

13.2.1 Public Comments

Public input into the watershed planning process has been encouraged and facilitated through a number of public meetings. The first meeting for the South Corvallis watershed was held in conjunction with meetings for the Oak Creek and Marys River watersheds on June 17, 1999, at the LaSells Stewart Center. During the meeting and a subsequent meeting, held September 30, 1999, residents were encouraged to share their knowledge of problem areas and to identify opportunities for improving the health of the South Corvallis watershed. Some general comments offered at the public meetings included:

- "Is there information on subsurface, underground geology? Substrate, etc.?"
- Resident was concerned about her well water quality (shallow well – 40 feet) on Allen Street. "Her neighbor's water well, her bed sheets are white after being washed."
- Another resident on Allen Street. "His 27 foot [well] went dry after 40 years. Now well is 57 feet deep. His neighbor's is 200 feet deep. Well depth necessary to reach water varies highly."
- "Are we looking at subsurface (groundwater) linkages with the stream from a fish habitat perspective?"
- "Are we modeling areas to west of Highway 99 (South Corvallis)?" [City staff responded that technical work was done with the South Corvallis Drainage Master Plan.]
- "Since South Corvallis has a larger than average acreage of land in the floodplain, will we do analysis of what would happen if we fill all those areas?"
- "Are Beaver Creek and Muddy Creek being considered? i.e., can we look at the entire stream and watershed to go beyond the political boundaries (into the County, etc.)?"
- "Somebody ditched their property into Mill Race. It was separate from development. We need standards (apart from development) triggered to set minimum parameters outside of development."

Public comments specific to the Mill Race and Goodnight Avenue drainage basins are summarized in Section 13.2.5.

13.2.2 City Staff Reports

City Engineering and Utilities Operations staff is familiar with most of the South Corvallis watershed through management of public improvements and field experience in the area. They provided input into the planning process by identifying known problem areas, recommending areas for possible stormwater improvements, and recounting the extent and duration of flooding during major storm events. The February 1996 storm caused flooding in several areas of South Corvallis, including Avery Park, along Crystal Lake Drive, and near the Marysville Golf Course.

13.2.3 Field Study Observations

No detailed field investigations were conducted for the South Corvallis watershed. Channel assessments were limited to areas adjacent to road crossings. Some information regarding the drainage system was collected in 1999 as part of the City's 1999/2000 Flood Mitigation Project.

13.2.4 Modeling Results

A computer model for the Mill Race and Goodnight Avenue drainage basins identified the hydraulic capacity and projected flows in the conveyance systems for existing and future build-out scenarios. The model based the existing scenarios on watershed conditions at the time of modeling (spring 2000). Future conditions were based on full development of the watershed (build-out) as identified in the City's Comprehensive Plan. A full range of storm events was modeled for the existing and future scenarios, including the 2-, 10-, 25-, and 100-year storm events.

The model showed that only one section of pipe in the Goodnight Avenue drainage basin is undersized for the City's 10-year design storm. The capacity of many pipes is limited by their flat slopes, but no pipes were identified as a source of flooding. None of the Mill Race drainage basin culverts was shown to be undersized for flows originating from the surrounding area. Overflows from the Marys and Willamette Rivers were not modeled, since the flooding problems associated with the two rivers is beyond the scope of this plan. A complete summary of all modeled segments is provided in Appendix C.

Table 13-1. Modeled Flow for Undersized Hydraulic Structures within the South Corvallis Watershed, cubic feet per second (cfs)

Reach/Location/Model segment	Full pipe or channel capacity	10-year storm flows		Flooding predicted by model	Flooding reported by staff or public
		Existing	Future		
Goodnight Avenue/Goodnight Avenue/GDN045	9.2	11.8	11.7[1]	No	No

[1] The apparent decrease in flow is within the model tolerance. The higher flow should be used for design purposes.

The hydrologic/hydraulic model also estimated flow velocities in channel segments to determine areas at risk for channel or streambank erosion. Stream velocities in excess of 4 feet per second (fps) may cause erosion of the streambank or streambed during the 2-year storm event—the storm size most responsible for determining the channel configuration. None of the velocities in the Mill Race or Goodnight Avenue drainage basin systems was high enough to cause channel erosion.

13.2.5 Stream Reach Summaries

Information for the South Corvallis watershed applies to either the Mill Race or Goodnight Avenue drainage basins. The Mill Race drainage basin was divided into four reaches. Public comments are shown as they were recorded during public meetings. Where required, clarifications are included in parentheses.

Goodnight Avenue Drainage Basin

Public Comments: "Concerned that development occurring on South 3rd Street that drains to Goodnight Creek has not been adequately planned to prevent impact to downstream property owners. Concerned that long-term maintenance requirements of detention facilities will be ignored by developed property owners and will impact flows into Goodnight Creek."

During one of the field observations, the manager of the mobile home park commented: "Flooding was not a problem in the park during the last winter (1999/2000). (He felt that) City efforts downstream had been successful." The mobile home park would like to convert the detention pond on its property to other uses.

City Staff Reports: Hathaway Drive was closed due to flooding during the February 1996 storm. Several bottlenecks in the system appear to exist. A 24-inch pipe along Goodnight Avenue is downstream of larger pipes. Roots have infiltrated and partially blocked a pipe along Goodnight Avenue. A diversion structure located at the south end of the mobile home park shunts flows to a detention pond and appears to be causing problems. Changes in City operation of this diversion structure have decreased flooding complaints. The detention pond at the mobile home park is a public facility located on private property, which raises access and maintenance issues.

Field Observations: The diversion structure located between Hathaway Drive and the mobile home park contains an orifice plate for detaining higher flows. Water backed up behind the plate is stored in the piped system and the detention pond located just to the east. As designed, the pond acts as a surge pond. The pond margins are mowed regularly and grass clippings are dumped on the banks.

Modeling Results: Modeling showed that the pipe along Goodnight Avenue between Deborah Place and Summerfield Drive is undersized for the 10-year design storm (existing and future). The problem pipe is 24 inches in diameter downstream of a 30-inch pipe from the south and a 24-inch pipe from the west. The pipe downstream of this section is 42 inches and is adequately sized. The pipe is shown to surcharge but not flood during the 10-year future storm event. The root blockage that is alleged to have caused past flooding problems was removed in summer/fall 2000 as part of the City's Flood Mitigation Project. The City will monitor the performance of the conveyance system and replace the pipe if flooding occurs. No velocity problems exist in this basin.

Mill Race Drainage Basin – Willamette River to Evanite Culvert

Public Comments: No public comments were received for this reach.

City Staff Reports: There is good vegetation along the stream, but the top of bank needs shade trees. This reach would be a good candidate for an adopt-a-stream program, since a lot of trash is tossed into the channel.

Field Observations: The BMX bike track is located in this reach.

Modeling Results: Modeling showed no capacity or velocity problems. Flooding along the Mill Race appears to be due to high water levels in the Marys and Willamette Rivers.

Mill Race Drainage Basin – Evanite Culvert to Highway 99

Public Comments: "The change in locations of Crystal Lake Drive [1989] diked water to make flooding worse."

City Staff Reports: Crystal Lake Drive on either side of the Mill Race drainage basin was closed due to flooding during the February 1996 storm. Since then, the culvert has been substantially increased at the Evanite factory. There is good vegetation along the stream, but the top of the bank needs shade trees. This reach would be a good candidate for the adopt-a-stream program, since a lot of trash is dumped in or along the channel.

Field Observations: The channel lacks tree cover through the lower part of the reach. Large open fields lie to the east of the Mill Race drainage basin, north and south of Crystal Lake Drive. A dense stand of young willows occupies most of the channel. The willows decrease the channel's capacity, but also decrease the erosion problems that are common upstream. The channel banks under the Crystal Lake Drive bridge are covered with concrete, limiting erosion there. From Highway 99 to downstream of Atwood Avenue, the canopy coverage is better, with many mature trees. However, the lower streambanks show signs of erosion and the channel bottom consists of stagnant pools interrupted by stretches of dry sediment deposits during dry summer months. Very little organic material, such as woody debris, is found in this section of the channel. Three large stormwater pipes discharge to the Mill Race beneath the Highway 99 bridge. A fourth pipe discharges immediately upstream of Highway 99 on the north bank.

Modeling Results: Modeling showed no capacity or velocity problems. Flooding is attributed to high water levels in the Marys and Willamette Rivers.

Mill Race Drainage Basin – Highway 99 to Allen Street

Public Comments: "Mill Race is disgustingly dirty—especially in lower flows (algae, pollutants, mosquitoes) and people dump into it. She has well water, which has lower water quality. (She lives on Allen Street)."
"Would like it (Mill Race) to be dry, when not carrying water."

"People are dumping into Mill Race channel between railroad tracks and 3rd Street."

City Staff Reports: Several roads in this reach had flooding problems during the February 1996 storm. Leonard Street, Pickford Street, and Wake Robin Avenue near the Marysville Golf Course all experienced high water on the roadways, as did Lilly Avenue at Highway 99. The stream corridor is very narrow in this reach and adjacent parking lots drain directly to the stream. Old tires and metal have been dumped into the stream and need to be removed. The water quality impact of runoff from the Marysville Golf Course should be considered.

Field Observations: A low spot in the channel just upstream of Highway 99 contains a long length of stagnant water with plentiful algae growth. An abundance of trash throughout this reach indicates that dumping is a problem. The stream banks show signs of lateral erosion. The outfall pipe from Marysville Golf Course discharges into the Mill Race drainage basin from under Allen Street. The channel downstream of Allen Street is eroded toward the bottom of the banks. The channel has little natural habitat value because it lacks woody debris or vegetation.

Modeling Results: Modeling showed no capacity or velocity problems. Flooding is due to high water levels in the Marys and Willamette Rivers.

Mill Race Drainage Basin – Allen Street to Marys River

Public Comments: "How important is the Mill Race in helping dissipate flow?"

City Staff Reports: This reach is outside of the city limits. It contains some good habitat that can be enhanced and/or protected.

Field Observations: The culvert under Allen Street is almost completely clogged with sediment at the downstream end; only the top one-foot remains free. The metal culvert is corroded and appears to be sagging under the road. Large trees shade the channel upstream of Allen Street. A number of logs are present along the channel bottom, representing potential fish habitat. However, the bottoms of the streambanks are eroding.

Modeling Results: Modeling showed no capacity or velocity problems, but the modeling assumed all existing pipes were clean, free flowing, and not filled with sediment. Flooding appears to be due to high water levels in the Marys and Willamette Rivers.

13.3 WATERSHED MANAGEMENT OPTIONS

Watershed management options for the Mill Race and Goodnight Avenue drainage basins were developed by the consultant team based on input from public comments, City staff reports, field observations, and modeling results. Table 13-2 lists recommended options including the following:

- Establishing stream buffers and planting trees in the lower reaches of the Mill Race drainage basin to provide shade to the channel.
- Stabilizing stream banks with log structures to prevent erosion in the upper reaches of the Mill Race drainage basin.
- Replacing the culvert under Allen Street.

Developing a way to keep the Mill Race channel flowing during summer months may solve problems with water quality, erosion, and habitat. The most likely alternative would be to open up the Mill Race channel to yearlong flow from Marys River. However, the idea has its own set of issues, including temperature, TMDL requirements related to the Endangered Species Act, and water rights that would have to be addressed. A feasibility study is recommended to investigate the merits of augmenting Mill Race flow with water from the Marys River. Coordination with federal, state, and local officials will be required, as well as additional surveying and engineering analysis.

During public meetings, citizens raised concerns regarding the current recommendations in the SCDMP. Citizens were concerned that City-owned airport and industrial park lands needed to be considered for water quality recommendations. These issues have been included in Table 13-2.

Citizens also expressed concerns about the ability to use swales instead of large underground pipe systems for stormwater conveyance as recommended in the SCDMP. The recommendations included in this SWMP may result in adjustments to the recommendations in the SCDMP. The SCDMP recommendations can be reviewed for consistency with the new SWMP on a case-by-case basis.

Short- and long-term recommendations for South Corvallis are listed in Table 13-3 and 13-4, respectively. The general locations of the short-term projects are shown in Figure 13-4, while long-term projects are shown in Figure 13-5.

Table 13-2. South Corvallis Options

Reach	Abridged observations	Recommended activity	Timing
Goodnight Avenue Basin	1) Flooding was not a problem at trailer park during the last winter.	a. Monitor area to ensure changes in City operation of diversion structure remain effective.	Short-term
	2) Hathaway Drive closed to flooding during 1996.	a. Monitor to ensure removal of root blockage in pipe along Goodnight Avenue prevents flooding.	Short-term
	3) Public detention pond located on private property acting as surge pond.	a. Surge pond is not required. City should investigate other use for this land.	Long-term
Mill Race Basin – Willamette River to Evanite Culvert	1) Good reach for community stewardship. Top of bank lacks shade trees.	a. Community involvement opportunity for tree planting effort.	Short-term
Mill Race Basin – Evanite Culvert to Highway 99	1) Good reach for community stewardship. Top of bank lacks shade trees.	a. Community involvement opportunity for tree planting effort.	Short-term
	2) Large open fields lie to east of the Mill Race at Crystal Lake Drive.	a. Protect existing habitat by establishing larger stream buffer in this area.	Short-term
	3) Willows decrease channel capacity but prevent erosion.	a. Maintenance required to thin willow stands to improve passage of flows.	Short-term
	4) Erosion along lower streambanks downstream of Highway 99.	a. Stabilize with structures along banks that also provide habitat value.	Long-term
		b. Decrease flow variations along the Mill Race to control erosive forces. (See last Mill Race recommendation in table.)	Long-term
	5) Stagnant water interspersed with exposed sediment deposits.	a. Increase flow in the Mill Race during summer. (See last Mill Race recommendation in table.)	Long-term
	6) The channel lacks large, instream woody habitat downstream of Highway 99.	a. Anchor large woody debris in channel.	Long-term
Mill Race Basin – Highway 99 to Allen Street	1) Mill Race contains algae, pollutants, and mosquitoes.	a. Increase flows in the Mill Race during summer. (See last recommendation in table.)	Long-term
	2) Dumping of trash in the Mill Race.	a. Educate public on importance of water quality.	On going
	3) Several roads had problems with flooding in 1996.	a. Flooding due to high water levels in Marys and Willamette Rivers. Provide information to homeowners on flood proofing techniques for their homes.	Short-term
	4) Narrow stream corridor with parking lots draining directly to stream.	a. Develop citywide ordinances for stream buffer zones to protect instream and riparian habitat.	On going

Table 13-2. South Corvallis Options (continued)

Reach	Abridged observations	Recommended activity	Timing
		b. Develop citywide ordinances requiring treatment of parking lot runoff.	On going
	5) Stagnant water with algae.	a. Increase summertime flows through the Mill Race. (See last Mill Race recommendation in table.)	Long-term
	6) Erosion problems along lower bank throughout reach.	a. Stabilize with structures along banks that also provide habitat value.	Long-term
		b. Decrease flow variations along the Mill Race to control erosive forces. (See last Mill Race recommendation in table.)	Long-term
	7) Outfall pipe from Marysville Golf Course at Allen Street. Golf course is outside City limits.	a. Coordinate with Benton County to develop ordinances requiring chemical management plans to reduce the potential of fertilizers, herbicides, and pesticides from contaminating stormwater runoff from golf courses, parks, playgrounds, and other large, non-native grassy areas.	Short-term
	8) Channel lacking habitat, woody debris downstream of Allen Street.	a. Anchor large woody debris in channel.	Long-term
Mill Race Basin – Allen Street to Marys River	1) Reach contains good habitat that should be protected.	a. Develop citywide ordinances for stream buffer zones to protect instream and riparian habitat.	On going
	2) Culvert under Allen Street is filled with sediment and structurally failing.	a. Replace culvert.	Short-term
	3) Lower edge of streambanks are failing.	a. Work with Benton County to stabilize with structures along stream banks that also provide habitat value. These can be worked in with large woody debris already in this stream reach.	Long-term
	4) Re-connect the Mill Race to Marys River to provide summertime flows through the Mill Race.	a. Conduct feasibility study to identify regulatory (environmental and water rights) and engineering issues with reconnecting the Mill Race with Marys River.	Long-term
Airport area City-owned land	1) Do not use Dry Creek for water quality.	a. Implement citywide policies to protect stream channels.	On going
	2) Meet water quality requirements of HB1010 for all City lands in agricultural production.	a. Implement citywide policies to address water quality.	On going
	3) Implement a monitoring program for airport to address sludge application procedures.	a. Implement citywide policies to monitor stormwater quality.	On going

Table 13-3. South Corvallis Short-Term Program

Reach	Recommended activity	Capital cost ($)	Annual O&M ($)	Project type[1]
Goodnight Avenue Basin	1) Monitor to ensure changes in City operation of diversion structure remain effective.	NA	80	☑
	2) Monitor to ensure that removal of root blockage in pipe along Goodnight Avenue prevents flooding.	NA	80	
Mill Race Basin – Willamette River to Evanite Culvert	1) Community involvement opportunity for tree planting effort.	1,600	80	Orange line
Mill Race Basin – Evanite Culvert to Highway 99	1) Community involvement opportunity for tree planting effort.	3,200	160	Orange line
	2) Protect existing habitat by establishing stream buffer and interpretive trail in this area.	12,000	600	
	3) Maintenance required to thin willow stands near Crystal Lake Drive to allow passage of flows.	NA	960	
Mill Race Basin – Highway 99 to Allen Street	3) Flooding due to high water levels in Marys and Willamette Rivers. Educate homeowners on flood proofing techniques for their homes.	20,000	NA	
	7) Coordinate with Benton County to develop ordinances requiring chemical management plans to reduce the potential of fertilizers, herbicides, and pesticides from contaminating stormwater runoff from golf courses, parks, playgrounds, and other large, non-native grassy areas.	8,000	NA	
Mill Race Basin – Allen Street to Marys River	2) Replace culvert.	9,100	455	
Total		**53,900**	**2,415**	

[1]Project types are in the Figure 13-4 map legend.
NA=Not Applicable

Table 13-4. South Corvallis Long-Term Program

Reach	Recommended activity	Capital cost ($)	Annual O&M ($)	Project type[1]
Goodnight Avenue Basin	3) Investigate sale to trailer court.	2,000	NA	
Mill Race Basin – Evanite Culvert to Highway 99	4) Stabilize banks with structures along banks that also provide habitat value.	63,000	3,150	Green line
	6) Anchor large woody debris in channel to improve habitat and stabilize channel bottom.	20,000	1,000	
Mill Race Basin – Highway 99 to Allen Street	6) Stabilize banks with structures that also provide habitat value.	70,000	3,500	Green line
	8) Anchor large woody debris in channel to improve habitat and stabilize channel bottom.	12,000	600	
Mill Race Basin – Allen Street to Marys River	3) Work with Benton County to stabilize with structures that also provide habitat value. These can be worked in with large woody debris already in this stream reach.	2,000	NA	Green line
	4) Conduct feasibility study to identify regulatory (environmental and water rights) and engineering issues with re-connection of the Mill Race to Marys River.	30,000	NA	
Total		**199,000**	**8,250**	

[1]Project types are in the Figure 13-5 map legend.

NA=Not Applicable

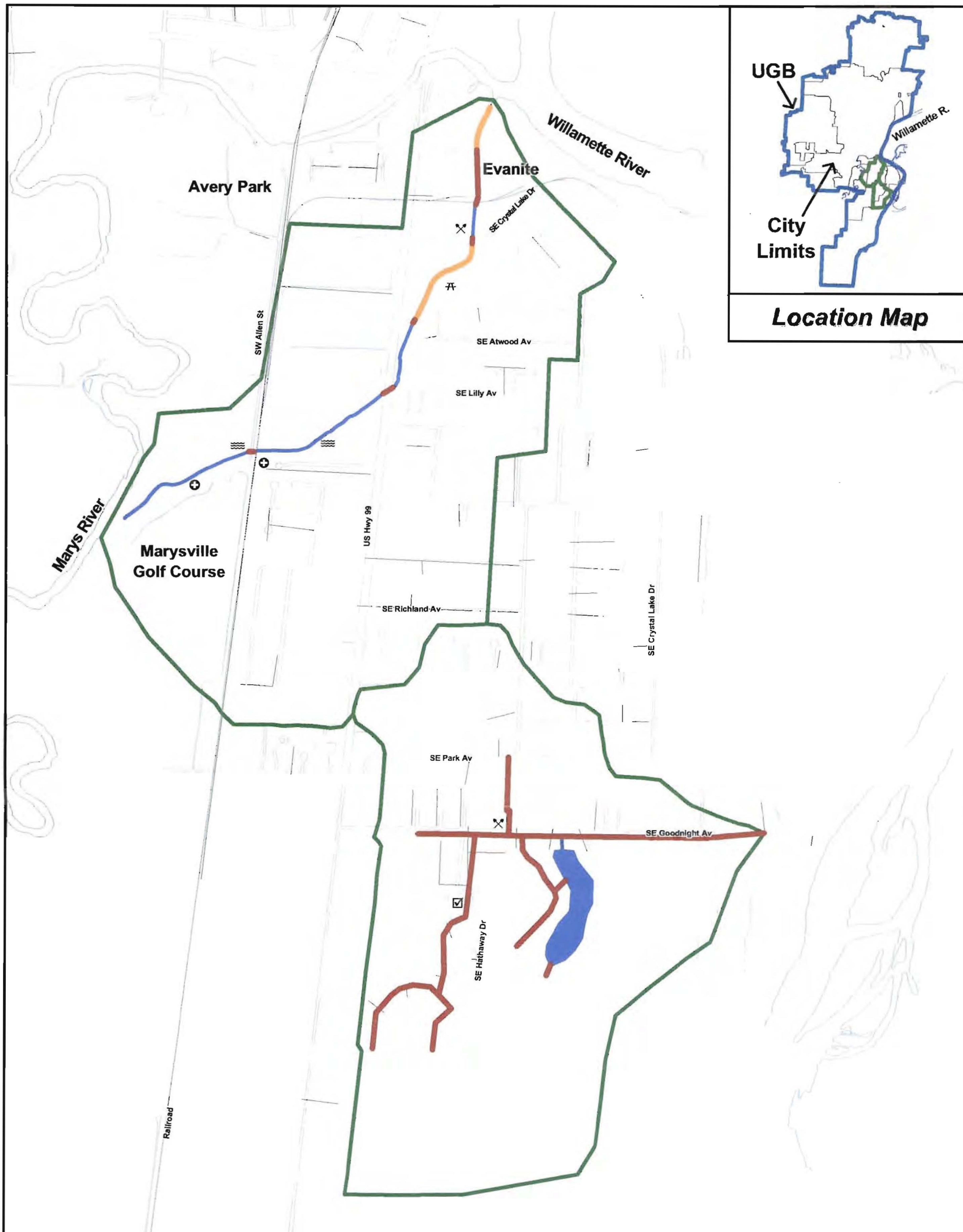


Figure 13-4 Short Term Project Locations

LEGEND

- Pipes/Bridges
- Channels
- Basin Boundary
- Bank Stabilization
- Canopy Revegetation
- Channel Improvement
- Replace Pipe/Bridge
- Fish Passage
- Buffer/Riparian Habitat
- Floodplain Reconnection
- Water Quality BMP
- Flood BMP
- Maintenance
- Monitor
- Multi-Use Facility

N

Feet 250 0 250 500 750 1000 Feet

CORVALLIS Public Works Department

BROWN AND CALDWELL and Associated Firms

report/figures/final/Fig13-4.wor, November 10, 2000, base data from City of Corvallis GIS Department

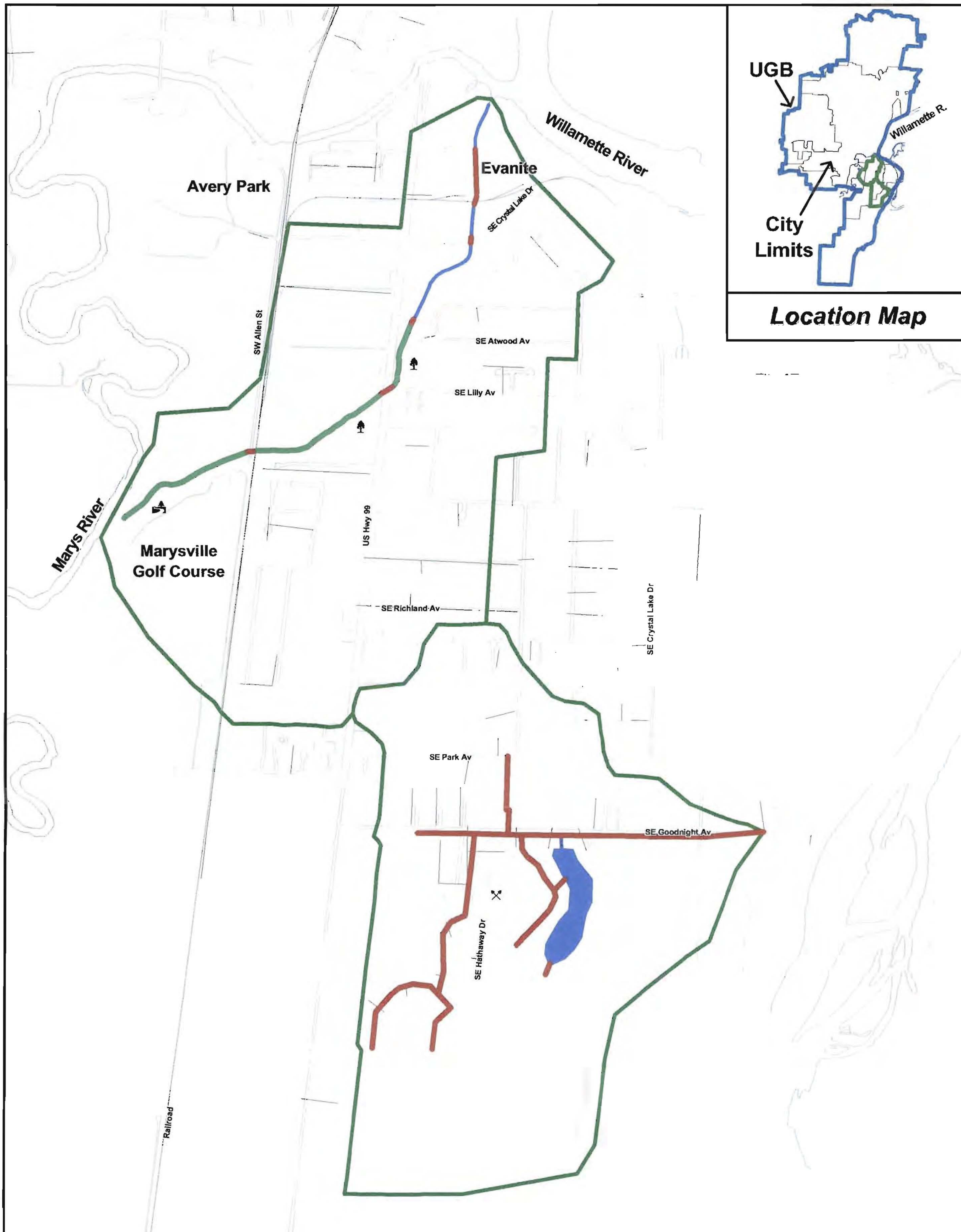
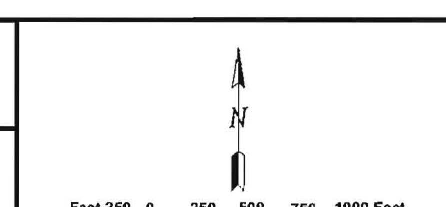


Figure 13-5 Long Term Project Locations

LEGEND

- Pipes/Bridges
- Bank Stabilization
- Replace Pipe/Bridge
- Floodplain Reconnection
- Maintenance
- Channels
- Canopy Revegetation
- Fish Passage
- Water Quality BMP
- Monitor
- Basin Boundary
- Channel Improvement
- Buffer/Riparian Habitat
- Flood BMP
- Multi-Use Facility



CORVALLIS Public Works Department

BROWN AND CALDWELL and Associated Firms

report/figures/final/Fig13-5.wor, November 10, 2000, base data from City of Corvallis GIS Department

CHAPTER 14

IMPLEMENTATION PLAN

This chapter describes the City's plan for implementing the improvements recommended by this Stormwater Master Plan (SWMP). The total program, excluding land acquisition, includes approximately $11,000,000 in capital improvements and over $340,000 in annual operation and maintenance (O&M) costs. Implementation of the projects is subject to funding limitations and to existing and future state and federal regulations. The timing of future development also influences implementation.

14.1 RECOMMENDED CITYWIDE IMPROVEMENTS

The SWMP outlines projects to improve the quality of stormwater and stream flow, protect property from flooding, protect the natural resources of upland areas, maintain natural flooding in the floodplain, and protect natural stream systems. The Stormwater Planning Committee (SWPC) developed evaluation criteria that were used in the development of the projects to help ensure that the overall objectives of the community were being met. A description of the evaluation criteria is in Chapter 2.

For purposes of implementation, the recommended projects were categorized into short-term and long-term programs. The short-term program identifies the immediate needs of the stormwater system within each watershed and implements improvements over an approximate 10-year period. The long-term program represents projects to further protect and restore the health of the watershed that would be implemented over a longer time frame, generally upon complete implementation of the short-term program. In some cases, long-term programs may be implemented concurrent with the short-term program, especially when the implementation is staged over a long period of time. This categorization provides guidance to the City for funding and implementing the recommendations. City staff may move projects between the short- and long-term programs and modify the implementation priority within each of the programs as required to meet the specific and changing needs of the community and to take advantage of funding opportunities that may become available.

Table 14-1 summarizes the estimated costs of recommended improvements for the eight watersheds. In addition, the estimated cost to provide end-of-pipe water quality treatment for direct stormwater discharges to City streams has been included. This capital improvement was prioritized by citizens during the review of the draft SWMP. For the purpose of estimating the cost of end-of-pipe water quality treatment, it was assumed that stormwater quality manholes would be installed. The cost for each installed unit is approximately $10,500. It is estimated that the City maintains approximately 270 outfall structures with a total cost to retrofit of about $2.8 million.

The costs summarized in Table 14-1 are planning level or order-of-magnitude estimates as defined in Chapter 3. Capital costs and O&M costs are shown. The cost of land acquisition or easements is not included in the estimates and should be determined during pre-design activities.

Table 14-1. Recommended Capital and O&M Improvements[1]

Watershed	Short-Term Program		Long-Term Program		Total Program	
	Capital, $	O&M, $	Capital, $	O&M, $	Capital, $	O&M, $
Dixon Creek	2,507,000	81,600	450,000	17,000	2,957,000	98,600
Squaw Creek	155,000	7,900	2,299,000	95,300	2,454,000	103,200
Jackson/Frazier/Village Green Creeks	192,000	3,800	208,000	9,000	400,000	12,800
Sequoia Creek	202,000	23,400	461,000	13,500	663,000	36,900
Garfield Basin	232,000	4,400	0	0	232,000	4,400
Oak Creek	435,000	800	799,000	20,900	1,234,000	21,700
Marys River	32,000	1,800	0	0	32,000	1,800
South Corvallis	54,000	2,400	199,000	8,300	253,000	10,700
End-of-Pipe Treatment	2,835,000	54,000	0	0	2,835,000	54,000
Total	6,644,000	180,100	4,416,000	164,000	11,060,000	344,100

[1] See Table 14-4 for the total cost of SWMP recommendations.

The total costs of capital improvements for the two programs are roughly equal in magnitude. However, the distribution of costs between the two programs varies considerably by watershed. For example, in the Dixon Creek watershed, the higher costs associated with the short-term program are the result of numerous undersized pipes along Buchanan Avenue, Kings Boulevard, and Grant Avenue, and from recommendations to regrade and stabilize the streambanks at several locations. As part of the short-term program, these projects will provide great benefit to the community and should be implemented as soon as possible within the constraints previously described. By contrast, most of the capital costs associated with the Squaw Creek watershed are in the long-term program. The long-term recommendations include several stream channel and bank improvements that will provide benefit to the community, but have a lower priority than projects in the short-term program.

There are multiple projects recommended within both the short- and long-term programs. Within each program, the priority ranking of projects for implementation depends on the needs of the City and community:

- Protects human health, safety, and property
- Protects existing City capital investments/system reliability
- Satisfies regulatory or contractual requirements
- Enhances or protects the environment
- Provides for growth and economic development
- Reduces long-term City costs

Once prioritized, a tentative schedule can be developed for the implementation of each project. The schedule will rely on the community's willingness to support stormwater utility rates and system development charges. A rate study should follow the adoption of this SWMP to establish charges that will be acceptable to the community. Once fees have been established, the City can determine the size of the capital program that can be completed in any given year and establish a multiple-year implementation schedule.

14.2 NEW POLICIES

New development and re-development within the Corvallis urban growth boundary consist of public and private construction activities. The City defines where and how construction activities and growth occur through the development and enforcement of public policies, standards, and codes. To be more responsive to the community's objectives for stormwater management, the SWPC and the City have developed a number of new policies to augment the current City Comprehensive Plan. The new policies identified in Chapter 5 apply to municipal, residential, industrial, and commercial development. Along with the City's other suite of planning documents, the new policies provide the framework to encourage appropriate development that will preserve or enhance flow and quality characteristics of stormwater runoff, and help protect natural riparian areas within local watersheds.

14.2.1 New Policy Purpose and Adoption

New policies were developed to address specific issues identified by the City and the SWPC. The issues covered a range of stormwater-related management topics, including water quality, water quantity, uplands natural resources, floodplains, and stream systems. The City's adoption of this SWMP includes the adoption of the enclosed policies. The policies will augment the existing Comprehensive Plan as well as all other City planning documents.

14.2.2 Policy Implementation Costs

Implementation of new policies includes the expense of establishing the initial inventory or criteria, implementing the action, and the long-term management costs. Policy recommendations from other efforts, such as the City's Natural Resource Scoping Project, may also impact implementation costs. For instance, a policy that requires the protection of existing stream shading presumes that areas have already been identified. To implement this policy, an inventory is required of existing shaded areas and of areas where shade restoration opportunities exist. Some policies have long-term financial impacts, both to the City's operating budget and to citizens.

The City's response to the Endangered Species Act (ESA) will influence requirements for stream buffers or setbacks and will affect the cost of land acquisition. The City will need to identify and plan for these additional costs. Using the same example as above, easements or land acquisitions may be required to support the stream shading policy and other policies defined in Chapter 5. As areas to be protected or enhanced are identified, the cost of acquiring these properties must be determined and added to the City's capital improvement program (CIP) budget. The cost to implement the new policy recommendations will be evaluated at the time they are considered for implementation.

14.3 OTHER NON-CAPITAL RECOMMENDATIONS

In addition to policies, Chapter 5 includes two other non-capital recommendations for protecting and enhancing the City's streams and riparian areas. The recommendations are to (1) develop a public involvement and information program that includes a citizen-implemented stream watch or stream stewardship program (using City funds and other resources), and (2) to develop cross-jurisdictional agreements with Benton County and other major stakeholders to provide a true watershed approach to managing local streams. The implementation of the recommendations requires the active participation and leadership of the City to establish, manage, and fund them. The funding cost is included in Table 14-4 as part of policy implementation.

The need for a public involvement and information program lies with how city stormwater programs have traditionally been managed. In many cities, money for operating the stormwater system and improving the conveyance system has been of lower importance than sewage treatment/conveyance, water treatment/conveyance, and street improvements. While the community and public officials would respond with a temporary interest in stormwater management after flood events, that interest would evaporate with drier weather.

Today, stormwater management requires heightened awareness by the community and City staff to address the suite of regulations that impacts stormwater management in Corvallis, including the ESA, National Pollution Discharge Elimination System (NPDES) Phase II, Total Maximum Daily Loads (TMDL), and National Flood Insurance Program (NFIP). These regulations require more focus on stormwater system management than the City has historically provided. Failure to provide appropriate attention and financial support for managing stormwater has consequences, such as fines. Funding must be provided by a dedicated, permanent source of revenue supported by the community.

Public support can be developed through a public involvement and educational program. The program will help foster community support for funding necessary improvements, making the necessary code modifications, and keeping stormwater management at the forefront. Community support is required for stormwater management activities to be effective and to comply with the regulations. Fortunately, Corvallis already has a raised level of consciousness for stormwater management as evidenced by the City's annual Flood Mitigation and Stream Restoration projects, the interest of the community, and the dedication of the SWPC.

In addition to developing a public involvement program, Chapter 5 recommends that the City develop partnerships with other public entities, such as Benton County, the State of Oregon, and Oregon State University. Interagency agreements encourage public entities to act with the City to develop responsible guidelines for construction, operation, and maintenance activities. More detail on the need for these agreements is provided in Chapter 5.

14.4 STORMWATER FUNDING

This section summarizes the existing funding program for the City's stormwater management activities and presents the funding needs recommended by this SWMP.

14.4.1 Existing Proforma

The City's stormwater utility is a dedicated funding source for stormwater activities. Operating revenues generated for fiscal year 99-00 are listed in Table 14-2. Charges for service are primarily from stormwater monthly rates and include approximately $77,000 from miscellaneous sources. Total stormwater resources are $2,733,548 including carryover funds not spent from previous years.

Rate-based revenues are generated from a base of 13,562 customers as of July 2000. The rates are based on equivalent surface units (ESUs) with a tiered rate structure to account for differences in the quantity of stormwater runoff between residential and commercial development. The monthly rate for one ESU in fiscal year 99-00 was $4.23. Other revenues are generated by System Development Charges (SDCs). In fiscal year 99-00, SDC revenues were almost $44,000. The monthly rates and SDCs will be updated to include the funding recommendations of the SWMP. The new SDC rate structure may include new elements such as drainageway dedications, stream enhancement, and extra capacity infrastructure not currently included in the rate structure.

Table 14-2. Stormwater Resources

Operating Revenue	FY 99-00 $
Charges for Service	1,482,858
Miscellaneous	76,846
Total Revenue	1,559,704
Other and Carry-over Resources	1,173,844
Total Resources	2,733,548

Total stormwater expenses include operating costs, special projects, and capital improvement projects. The City's expenses for fiscal year 99-00 are listed in Table 14-3.

Table 14-3. Stormwater Expenses

Expenses	FY 99-00 Budgetary Basis, $
Operating Expenses	871,913
Special Projects	93,123
Total Operating Expenses	964,442
Capital Expenses	311,480
Total Expenses	1,275,922

The City's resources exceed expenses for fiscal year 99-00. This difference would carry-over in the fund balance to future years, providing a reserve to be used for one-time projects or emergencies. The City's five-year plan predicts a stormwater carry-over fund balance through fiscal year 04-05.

14.4.2 New Funding Requirements

The SWMP's recommendations for improving stormwater management throughout the City will impact the capital and operating budgets. A rate analysis is required to determine how user fees and system development charges will be affected by these additional projects. The rate analysis will also help the City determine the time period over which to complete the short- and long-term programs as influenced by the public's willingness to support the SWMP recommendations. Table 14-4 summarizes the costs of all recommendations provided by this SWMP, but does not include the cost of land.

Table 14-4. Total Cost of SWMP Recommendations

Activity	Short-Term Program	Long-Term Program	Total
Capital Fund:			
Capital projects	$6,644,000	$4,416,000	$11,060,000
Operating Fund:			
Operating projects	$180,100/year	$164,000/year	$344,100/year

14.5 ADDITIONAL REQUIREMENTS

In addition to capital and operating budget recommendations, the SWMP makes policy recommendations as discussed earlier and presented in Chapter 5. To achieve the objectives established for the policies, modifications will be required to other elements of the City's planning framework. Changes will be required in the Municipal Code, Land Development Code, Design Criteria Manual, and Standard Construction Specifications.

Each of the City's planning documents must be reviewed to determine the modifications required to support stormwater management activities and, specifically, to comply with regulations faced by the City: ESA, NPDES Phase II, TMDL, and NFIP. A systematic review of the City's documents at the time they are due for revision will reduce the administrative burden of reviewing and updating these documents now. However, complying with ESA may require that the City focus on updating some of these documents earlier.

REFERENCES

Anderson, C. W., T. M. Wood and J. L. Morace, *Distribution of Dissolved Pesticides and Other Water Quality Constituents in Small Streams, and their Relations to Land Use, in the Willamette River Basin, Oregon, 1996,* U.S. Department of the Interior, U.S. Geological Survey, Water Resources Investigations Report 97-4268, Portland, Oregon, 1997.

Barker, BL, RD Nelson, and MS Wigmosta, "Performance of detention ponds designed according to current standards," PSWQA Puget Sound Research '91 Conference Proceedings, Seattle, WA. 1991.

Bedient, P.B. and W.C. Huber, Hydrology and Floodplain Analysis, Addision-Wesley Publishing Co., Reading, MA. Second Addition, 1993.

Booth, D.B., "Runoff and Stream-Channel Changes Following Urbanization in King County, Washington," in *Engineering Geology in Washington, Volume II, Washington Division of Geology and Earth Resources Bulletin 78.*

Booth, D.B., and C.R. Jackson, "Urbanization of aquatic systems: Degradation thresholds, stormwater detection, and the limits of mitigation", in *Journal of the American Water Resources Association.* Vol. 33 (5): 1077- 1090, 1997.

City of Corvallis, *Corvallis Drainage Master Plan,* CH2M Hill, May 1981.

City of Corvallis, *Design Criteria Manual for Public Improvements,* July 1991.

City of Corvallis, *Dixon Creek Flood Reduction Analysis,* KCM, December 1997.

City of Corvallis, *Draft #2 Revised Corvallis Comprehensive Plan,* August 1998.

City of Corvallis, *South Corvallis Drainage Master Plan,* KCM, December 1998.

Ferguson, B.K., Stormwater Infiltration, Ann Arbor, Michigan: Lewis Publishers, 1994.

Horner, R.R., D.B. Booth, A. Azous, and C.W. May, "Watershed determinants of ecosystem functioning," in Effects of Watershed Development and Management on Aquatic Ecosystems (Roesner, LA, ed.). Proceedings of the ASCE Conference, Snowbird, UT. 1996.

Huber, W. C., J. P. Heaney, L. J. Nix, R. E. Dickinson, and D. J. Pulmann, "Stormwater Management Model User's Manual, Ver. III", EPA 600/2-84-109a (NTIS PB84-198432), November 1981.

Maryland Department of the Environment, *Maryland Stormwater Design Manual,* 1998.

May, C.W., R.R. Horner, J.R. Karr, B.W. Mar, and E.B. Welch, "The cumulative effects of urbanization on small streams in the Puget Sound Lowland Ecoregion," University of Washington, Seattle, WA. Unpublished.

North Carolina Sedimentation Control Commission, *Erosion and Sediment Control Planning and Design Manual*, 1988.

Oregon State University, "Report of the Oak Creek Action Team to Oregon State University," Office of Research, OSU, Corvallis, Oregon, June 2000.

Smoot, J.L. and R.D. Smith, *Soil Erosion Prevention and Sediment Control,* University of Tennessee, Knoxville, Water Resources, Civil and Environmental Engineering, 1999.

U.S. Department of Agriculture, *Stream Corridor Restoration: Principles, Practices, and Processes*, 1988.

U.S. Department of Agriculture, *Technical Release 55Urban Hydrology for Small Watersheds*, USDA Soil Conservation Service, 1986.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fishereies Service (NMFS), 50 CFR Part 223, *Endangered and Threatened Species; Final Rule Governing Take of 14 Threatened Salmon and Steelhead Evolutionarily Significant Units (ESUs)*, Federal Register Volume 65, Number 132, Page 42422, July 10, 2000.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fishereies Service (NMFS), 50 CFR Part 223, *Endangered and Threatened Species; Threatened Status for Two ESUs of Steelhead in Washington and Oregon (ESUs)*, Federal Register Volume 64, Number 57, Page 14517, March 25, 1999.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fishereies Service (NMFS), 50 CFR Part 223, *Endangered and Threatened Species; Threatened Status for Three Chinook Salmon Evolutionarily Significant Units (ESUs) in Washington and Oregon, and Endangered Status for One Chinook Salmon ESU in Washington*, Federal Register Volume 64, Number 56, Page 14308, March 24, 1999.

U.S. Environmental Protection Agency (EPA), 40 CFR Parts 9, 122, 123, and 124, *National Pollutant Discharge Elimination System—Regulations for Revision of the Water Pollution Control Program Addressing Storm Water Discharges,* Federal Register Volume 64, Number 64, Page 68722, December 8, 1999.

U.S. National Oceanic and Atmospheric Administration (NOAA) Atlas X, 1973.

Wigmosta, M.S., S.J. Burgess, and J.M. Meena, "Modeling and monitoring to predict spatial and temporal hydrologic characteristics in small catchments," USGS Water Resources Technical Report No. 137, 1994.

APPENDIX A
PUBLIC INVOLVEMENT

Public Opinion Survey
Summary of Stakeholder Surveys
Corvallis Chamber of Commerce Memorandum
Barney & Worth, Inc. Response to Chamber Memorandum
Evaluation Criteria
Citizen Input Workbook, Information Packet and Summary of Exercise
Citizen Input on Policies and Short/Long Term Basin Programs
Excerpts of Meeting Minutes from USC on 8/14/01 & 8/16/01

Corvallis Stormwater Master Plan

Summary:

Public Opinion Survey

Prepared for:

City of Corvallis
Stormwater Planning Committee

Prepared by:

McArthur & Associates
and
Barney & Worth, Inc.
1211 SW Fifth Ave., Suite 2100
Portland, OR 97204
Phone (503) 222-0146
Fax (503) 274-7955

In association with:

Brown and Caldwell

January 1998

Table of Contents

I. Executive Summary

Corvallis Stormwater Master Plan

In 1997, the City of Corvallis engaged a multi-disciplinary consultant team headed by the engineering firm Brown and Caldwell to recommend how to control flooding and manage other stormwater problems. The Corvallis Stormwater Master Plan is scheduled to be completed, and recommendations presented to the Corvallis City Council in 1999.

Public Opinion Survey

In December 1997 and January 1998, some 366 Corvallis residents were surveyed to seek their views on many important issues linked to the Corvallis Stormwater Master Plan. Interviews were conducted by telephone with Corvallis residents 18 years and older who were randomly selected. Participants were asked to share their views related to: stormwater issues and stormwater management practices; the nature and severity of flooding problems, causes and possible solutions; values and principles to guide decisionmaking; and costs (a copy of the questionnaire is attached in an appendix).

The survey questions were developed in collaboration with the Corvallis Stormwater Planning Committee.

Summary of Results

A summary of key points offered by the Corvallis residents surveyed regarding the Corvallis Stormwater Master Plan:

1. **Corvallis is a community of "stream people."** Almost half of the Corvallis residents surveyed (44%) live within six blocks of a stream – 13% within one block. Residents say their closest streams are the Willamette River (33%), Dixon Creek (20%) and Mary's River (13%).

2. **Many citizens aren't well informed about stormwater issues**, despite their proximity to streams. Forty percent say they don't know where stormwater drains in their neighborhood, and 29% aren't sure if there are unresolved stormwater issues. This lack of information contrasts with extraordinarily high education levels – 54% of all residents surveyed have at least a bachelors degree, and 22% have earned a post-graduate degree.

3. **A variety of unresolved stormwater issues are recognized in the community.** Nearly half (46%) suspect there are stormwater issues which must be addressed in the future. Top issues (see table) include surface pollutants entering streams (93% say this is very important or important); flooding of streets, homes and businesses (91%); and loss of stream habitat (88%).

Corvallis Stormwater Issues

Issue	% Very Important / Important	% Very Important
Surface pollutants entering streams	**93**	**62**
Flooding of streets, homes, businesses	**91**	**57**
Loss of stream habitat	**88**	**56**
Erosion along stream banks	87	42
Runoff from new development	86	47
Erosion from construction sites	86	40
Development in flood plains	84	53
Use of streams to drain runoff	81	35

4. **A large number of residents have first-hand experience with flooding.** Over one-third of survey participants (37%) say they have been affected by flooding. And for most of these, it has become a routine occurrence – over three-quarters (78%) are impacted by one or more flood events annually. However, for most of these residents the flooding is little more than an inconvenience. Only 22% of respondents who have experienced flooding report any damage to their homes, basements or garages.

5. **New development is a factor – but is not fingered as the main source** of Corvallis stormwater problems. As a possible cause of flooding, 31% of participants think new upstream development may be the leading cause vs. 34% who pinpoint "too much rain" as the likely culprit. Only 14% think developers should take the lead in solving stormwater problems, and only 12% say development fees should be the only source relied on to fund stormwater system improvements.

6. **Citizen values emphasize protecting streams, safeguarding publc safety, and preventing flood damage.** The principles supported by nearly all respondents (see table) include control erosion (rated as very important or important by 96%), prevent flood damage to homes / businesses (95%), prevent flood damage to streets / property (95%), protect stream habitat (94%) and improve stream water quality (93%).

Values to Guide Corvallis Stormwater Planning

Value	% Very Important / Important	% Very Important
Control erosion	**96**	**54**
Prevent flood damage to homes / businesses	**95**	**60**
Protect public safety	**95**	**55**
Prevent flood damage to streets / property	**95**	**48**
Protect stream habitat	**94**	**60**
Improve stream water quality	**93**	**52**
Meet statewide regulations	91	40
Provide public information	91	86
Control development	89	54
Protect wetlands	88	56
Minimize utility rates	73	23
Reduce City maintenance costs	71	17
Increase stream widths	66	16
Encourage public access to streams	62	17
Retain stormwater on-site	59	19

7. **Stormwater system costs are not yet an issue.** Two-thirds of all respondents (67%) say they don't know how much they are currently paying for stormwater drainage, and another 21% think they are paying over $10/month. Nearly half (45%) can't say if the fees are too high, and only 15% are concerned the fees are already too high.

8. **Future stormwater improvements should be funded through a combination of monthly rates and development fees.** If costs must rise in the future, a strong majority (72%) favors the combined approach to financing.

9. **The City of Corvallis is counted on to take the lead in addressing stormwater issues.** A solid majority (72%) says the City should have primary leadership responsibility, vs. 30% who expect private citizens to take charge.

Demographic Profile of Survey Participants

Highlights of key demographic characteristics of the 366 Corvallis residents surveyed regarding stormwater issues:

- Survey participants are equally split by sex: 50% female, 50% male
- Most are home owners: 63% own their homes, 35% rent
- There's a mix of long-time residents and newcomers: 51% have lived in Corvallis 10 years or longer
- Respondents are well-educated: 30% of those in 35-54 age group hold post-graduate degrees
- Most survey participants (59%) live in Northwest Corvallis

McArthur&Associates
4336 SW Condor Avenue
Portland, Oregon 97201
503/228-5565
Fax: 503/228-7456

CORVALLIS STORMWATER ASSESSMENT SURVEY DATA CROSS-TABULATIONS

January, 1998

Corvallis Stormwater Survey
January, 1998
Executive Summary of Results

Background
To establish a baseline of public opinion and identify public sentiment toward the management of stormwater in Corvallis, a telephone survey of 366 residents was conducted in late December, 1997 - early January, 1998. The results of the survey are consistently straightforward: While residents generally lack much knowledge of the specifics of their stormwater service, they fully recognize the importance of stormwater management to public safety and environmental protection. Development is not necessarily viewed as a negative, but Corvallis residents think it certainly impacts stormwater issues, and should be involved in (financing) improvements and enhancements to the City's stormwater system.

Stormwater and Corvallis Residents

- Generally, Corvallis residents appear to lack awareness of the specifics of their stormwater services. Four of ten residents say they don't know where the stormwater drains to in their neighborhood (30% - streams/rivers; 20% - catch basins in the street; 11% - ditches; 9% - pipes to the wastewater treatment plant). Over two-thirds (67%) of those surveyed say they don't know how much they pay monthly for their stormwater service; 21% believe they pay over $10 a month.
- The majority of residents either can't say whether their stormwater bills are too high, about right or relatively low (45%) or feel they pay about the right amount for their stormwater service (33%).
- While residents may not know the specifics of their stormwater service, nearly half (46%) have some awareness that there are unresolved issues with the management of stormwater in Corvallis. This awareness appears to cross most demographic segments, and does not necessarily correlate with first-hand experience with a stormwater problem. Those who have been affected by flooding (37%) do not appear to have significantly more awareness of unresolved stormwater management issues than those unaffected by flooding.
- Restricted access to home or workplace (48%) and flooded streets (42%) are the most frequent effects of flooding on residents. For those affected by flooding, the problem appears to be ongoing rather than a one time event. Seventy-eight percent of those experiencing flooding have had one or more event in each of the last two years.
- Not surprisingly, flooding of streets, homes and businesses (57% - "very important") and preventing flood damage to homes and businesses (60% - "very important") are of high priority to residents. Preventing flood damage

to streets and property is rated "very important" by 48% of the residents surveyed.

Stormwater and the Environment

- Corvallis residents clearly connect the importance of managing stormwater to the environment. Surface pollutants entering streams receives the highest "very important" rating (62%) of all issues reviewed. Additionally, 52% of those surveyed say improving stream water quality is "very important" for future stormwater management planning.
- Residents also consistently rate stream habitat very important. Fifty-six percent of those surveyed rate loss of stream habitat as "very important." Sixty percent of the survey respondents say protecting stream habitat is "very important" in planning future community stormwater management.
- The importance of water quality is also underscored as residents rate less highly the option of using streams to drain urban run-off (35% - "very important") and increasing stream corridor widths (16% - "very important").
- Currently, stream bank erosion is not rated as intensely important of an issue (42% - "very important"). However, when looking to the future, residents do rate controlling erosion as a very important (54%) component of community storm water management planning. Residents having been affected by flooding are more likely to rate stream bank erosion as very important.
- Similarly, a majority of residents (56%) rate protecting wetlands as "very important" in planning future community stormwater management.
- Residents are willing to pay their share of improved stormwater management. With the exception of those who say their stormwater bills are already too high, the vast majority (72%) of residents surveyed say improvements should be paid through a combination of monthly utility bills and new development fees.

Stormwater and New Development

- Corvallis residents have less intense responses toward the role of development on stormwater management issues than they do when relating stormwater to environmental issues. Erosion from construction sites, runoff from new development, and development in flood plains are rated "very important" by 40% to 53% of the survey respondents; in comparison, "very important" ratings for environmental/stormwater issues range from 56% to 62% of those polled.
- This not painting development as the "bad guy" comes despite that two of the leading causes of recent flooding in Corvallis name development: new/too much upstream development (31%) and poor development

standards/standards not enforced (22%). Too much rain (34%) is the top response.

- For residents, controlling development is important in planning future community stormwater management, but less important than preventing flood damage to homes/businesses and protecting stream habitat.
- State-of-the-art options for future management of stormwater in new developments such as retaining stormwater on-site receive mixed reviews. The high percentage of "don't knows" (30%) indicates many residents lack familiarity with the newer techniques in stormwater management.

Stormwater and the City of Corvallis

- While Corvallis residents are willing to share responsibility for paying for stormwater management improvements, they are equally of the opinion that the City of Corvallis should be responsible for taking actions to enhance urban streams and better manage stormwater drainage problems in the future. Seventy-two percent of the residents polled say stormwater management activities are the responsibility of the City, 30% say private citizens should (also) be responsible and 14% say developers (also) have responsibility.
- For residents, the City's stormwater management planning priority should be protecting public safety (55% - "very important"). Some 40% of those surveyed say meeting state-wide regulations is "very important."
- Beyond public safety and environmental protection, other stormwater management activities are clearly less important to residents: Providing public information (36% - "very important"), minimizing utility rates (23% - "very important"), reducing city maintenance costs (17% - "very important"), and encouraging public access to streams (17% - "very important").

Importance of Stormwater Management Activities
Table 1

	Very Important	Very Important/Important
Surface pollutants entering streams	62%	93%
Flooding of streets, homes, businesses	57%	91%
Loss of stream habitat	56%	88%
Development in flood plains	53%	86%
Rapid run-off from new development	47%	86%
Erosion along stream banks	42%	87%
Erosion from construction sites	40%	86%
Use of streams to drain urban run-off	35%	81%

Importance in Planning Future Community Stormwater Management
Table 2

	Very Important	Very Important/Important
Preventing flood damage to homes and businesses	60%	95%
Protecting stream habitat	60%	94%
Protecting wetlands	56%	88%
Protecting public safety	55%	95%
Controlling erosion	54%	96%
Controlling development	54%	89%
Improving stream water quality	52%	93%
Preventing flood damage to streets and property	48%	95%
Meeting state-wide regulations	40%	91%
Providing public information on stormwater management	36%	91%
Minimizing utility rates	23%	73%
Retaining stormwater on-site for new development	19%	59%
Reducing city maintenance costs	17%	71%
Encouraging public access to streams	17%	62%
Increasing stream corridor widths	16%	66%

MCARTHUR ASSOCIATES
(503) 228-5565

1. HOW FAR DO YOU LIVE FROM THE NEAREST STREAM OR RIVER?

CORVALLIS
STORMWATER SURVEY
JANUARY, 1998

	TOTAL	---GENDER----		--------AGE---------			------EDUCATION-----			--RESIDENCE--		-----------AREA------------				--RESIDENCY--	
		MALE	FEMALE	18-34	35-54	55PLUS	HIGH/ LESS	SOME COLLEG	COLLEG GRAD	OWN	RENT	NORTH EAST	NORTH WEST	SOUTH EAST	SOUTH WEST	<10YRS	10YRS>
TOTAL RESPONDENTS	366	184	182	100	158	102	62	105	195	230	129	34	217	27	75	176	188
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
ONE CITY BLOCK	46	21	25	13	22	10	5	10	31	31	14	4	27	3	11	28	18
	13%	11%	14%	13%	14%	10%	8%	10%	16%	13%	11%	12%	12%	11%	15%	16%	10%
TWO TO SIX CITY BLOCKS	113	63	50	32	55	26	24	31	58	72	39	9	60	14	28	53	60
	31%	34%	27%	32%	35%	25%	39%	30%	30%	31%	30%	26%	28%	52%	37%	30%	32%
MORE THAN SIX CITY BLOCKS	199	97	102	53	79	63	31	62	102	124	71	21	125	9	35	91	106
	54%	53%	56%	53%	50%	62%	50%	59%	52%	54%	55%	62%	58%	33%	47%	52%	56%
DON'T KNOW	8	3	5	2	2	3	2	2	4	3	5	0	5	1	1	4	4
	2%	2%	3%	2%	1%	3%	3%	2%	2%	1%	4%		2%	4%	1%	2%	2%

MCARTHUR ASSOCIATES
(503) 228-5565

1. HOW FAR DO YOU LIVE FROM THE NEAREST STREAM OR RIVER?

		--UNRESOLVED-		-AFFEC FLOOD-		------STORMWATER BILL------			
	TOTAL	YES	NO/DK	YES	NO	HIGH	RIGHT	LOW	DK/NOP
TOTAL RESPONDENTS	366 100%	170 100%	196 100%	136 100%	230 100%	54 100%	120 100%	28 100%	164 100%
ONE CITY BLOCK	46 13%	21 12%	25 13%	23 17%	23 10%	7 13%	15 13%	4 14%	20 12%
TWO TO SIX CITY BLOCKS	113 31%	62 36%	51 26%	47 35%	66 29%	18 33%	37 31%	12 43%	46 28%
MORE THAN SIX CITY BLOCKS	199 54%	82 48%	117 60%	62 46%	137 60%	29 54%	68 57%	11 39%	91 55%
DON'T KNOW	8 2%	5 3%	3 2%	4 3%	4 2%	0	0	1 4%	7 4%

MCARTHUR ASSOCIATES
(503) 228-5565

2. WHICH STREAM OR RIVER?

CORVALLIS
STORMWATER SURVEY
JANUARY, 1998

		GENDER		AGE			EDUCATION			RESIDENCE		AREA				RESIDENCY	
	TOTAL	MALE	FEMALE	18-34	35-54	55PLUS	HIGH/ LESS	SOME COLLEG	COLLEG GRAD	OWN	RENT	NORTH EAST	NORTH WEST	SOUTH EAST	SOUTH WEST	<10YRS	10YRS>
TOTAL RESPONDENTS	366	184	182	100	158	102	62	105	195	230	129	34	217	27	75	176	188
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
WILLAMETTE RIVER	120	58	62	42	41	34	29	42	47	59	57	17	64	20	12	58	61
	33%	32%	34%	42%	26%	33%	47%	40%	24%	26%	44%	50%	29%	74%	16%	33%	32%
DIXON CREEK	73	33	40	10	37	26	12	16	45	60	12	3	67	0	2	25	48
	20%	18%	22%	10%	23%	25%	19%	15%	23%	26%	9%	9%	31%		3%	14%	26%
MARY'S RIVER	47	24	23	10	18	18	5	10	31	36	9	0	10	4	31	20	27
	13%	13%	13%	10%	11%	18%	8%	10%	16%	16%	7%		5%	15%	41%	11%	14%
OAK CREEK	18	13	5	1	11	6	3	2	13	16	2	0	14	0	3	3	15
	5%	7%	3%	1%	7%	6%	5%	2%	7%	7%	2%		6%		4%	2%	8%
SQUAW CREEK	6	3	3	0	4	2	1	2	3	5	1	0	0	0	6	2	4
	2%	2%	2%		3%	2%	2%	2%	2%	2%	1%				8%	1%	2%
JACKSON/FRAZIER CREEK	4	3	1	1	2	1	0	0	4	2	2	0	4	0	0	3	1
	1%	2%	1%	1%	1%	1%			2%	1%	2%		2%			2%	1%
SEQUOIA CREEK	2	0	2	0	1	1	0	1	1	2	0	0	0	0	2	2	0
	1%		1%		1%	1%		1%	1%	1%					3%	1%	
MUDDY CREEK	2	2	0	1	0	1	0	1	1	2	0	0	0	0	2	0	2
	1%	1%		1%		1%		1%	1%	1%					3%		1%
OTHER	4	2	2	1	2	1	0	1	3	3	1	2	1	0	1	3	1
	1%	1%	1%	1%	1%	1%		1%	2%	1%	1%	6%	*		1%	2%	1%
DON'T KNOW	90	46	44	34	42	12	12	30	47	45	45	12	57	3	16	60	29
	25%	25%	24%	34%	27%	12%	19%	29%	24%	20%	35%	35%	26%	11%	21%	34%	15%

MCARTHUR ASSOCIATES
(503) 228-5565

2. WHICH STREAM OR RIVER?

		--UNRESOLVED-		-AFFEC FLOOD-		------STORMWATER BILL------			
	TOTAL	YES	NO/DK	YES	NO	HIGH	RIGHT	LOW	DK/NOP
TOTAL RESPONDENTS	366 100%	170 100%	196 100%	136 100%	230 100%	54 100%	120 100%	28 100%	164 100%
WILLAMETTE RIVER	120 33%	51 30%	69 35%	51 38%	69 30%	17 31%	34 28%	8 29%	61 37%
DIXON CREEK	73 20%	40 24%	33 17%	27 20%	46 20%	12 22%	31 26%	7 25%	23 14%
MARY'S RIVER	47 13%	19 11%	28 14%	14 10%	33 14%	6 11%	13 11%	5 18%	23 14%
OAK CREEK	18 5%	12 7%	6 3%	5 4%	13 6%	4 7%	7 6%	2 7%	5 3%
SQUAW CREEK	6 2%	5 3%	1 1%	3 2%	3 1%	0	1 1%	0	5 3%
JACKSON/FRAZIER CREEK	4 1%	2 1%	2 1%	1 1%	3 1%	0	1 1%	1 4%	2 1%
SEQUOIA CREEK	2 1%	0	2 1%	0	2 1%	0	1 1%	0	1 1%
MUDDY CREEK	2 1%	1 1%	1 1%	2 1%	0	0	1 1%	0	1 1%
OTHER	4 1%	3 2%	1 1%	1 1%	3 1%	0	3 3%	0	1 1%
DON'T KNOW	90 25%	37 22%	53 27%	32 24%	58 25%	15 28%	28 23%	5 18%	42 26%

MCARTHUR ASSOCIATES
(503) 228-5565

3. DO YOU KNOW WHERE THE STORMWATER DRAINS TO IN YOUR NEIGHBORHOOD?
(MULTIPLE RESPONSE)

CORVALLIS
STORMWATER SURVEY
JANUARY, 1998

		---GENDER----		--------AGE---------			------EDUCATION-----			--RESIDENCE--		-----------AREA-----------				--RESIDENCY--	
	TOTAL	MALE	FEMALE	18-34	35-54	55PLUS	HIGH/ LESS	SOME COLLEG	COLLEG GRAD	OWN	RENT	NORTH EAST	NORTH WEST	SOUTH EAST	SOUTH WEST	<10YRS	10YRS>
TOTAL RESPONDENTS	366	184	182	100	158	102	62	105	195	230	129	34	217	27	75	176	188
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
TO STREAMS OR RIVERS	108	60	48	24	55	29	11	27	70	79	28	6	59	11	28	46	61
	30%	33%	26%	24%	35%	28%	18%	26%	36%	34%	22%	18%	27%	41%	37%	26%	32%
TO CATCH BASINS IN THE STREET	75	39	36	17	30	27	9	19	47	49	25	5	50	4	14	33	42
	20%	21%	20%	17%	19%	26%	15%	18%	24%	21%	19%	15%	23%	15%	19%	19%	22%
TO DITCHES	41	22	19	9	21	10	7	9	25	34	7	5	16	4	14	13	28
	11%	12%	10%	9%	13%	10%	11%	9%	13%	15%	5%	15%	7%	15%	19%	7%	15%
IN PIPES TO THE WASTEWATER TREATMENT PLANT	34	17	17	7	9	16	6	12	15	21	11	3	22	4	4	8	25
	9%	9%	9%	7%	6%	16%	10%	11%	8%	9%	9%	9%	10%	15%	5%	5%	13%
DON'T KNOW	145	69	76	53	57	33	35	49	58	72	69	19	85	10	25	86	59
	40%	38%	42%	53%	36%	32%	56%	47%	30%	31%	53%	56%	39%	37%	33%	49%	31%

MCARTHUR ASSOCIATES
(503) 228-5565

3. DO YOU KNOW WHERE THE STORMWATER DRAINS TO IN YOUR NEIGHBORHOOD?
(MULTIPLE RESPONSE)

		--UNRESOLVED-		-AFFEC FLOOD-		------STORMWATER BILL------			
	TOTAL	YES	NO/DK	YES	NO	HIGH	RIGHT	LOW	DK/NOP
TOTAL RESPONDENTS	366 100%	170 100%	196 100%	136 100%	230 100%	54 100%	120 100%	28 100%	164 100%
TO STREAMS OR RIVERS	108 30%	63 37%	45 23%	50 37%	58 25%	22 41%	39 33%	7 25%	40 24%
TO CATCH BASINS IN THE STREET	75 20%	37 22%	38 19%	28 21%	47 20%	12 22%	27 23%	5 18%	31 19%
TO DITCHES	41 11%	21 12%	20 10%	22 16%	19 8%	4 7%	10 8%	6 21%	21 13%
IN PIPES TO THE WASTEWATER TREATMENT PLANT	34 9%	18 11%	16 8%	14 10%	20 9%	6 11%	14 12%	4 14%	10 6%
DON'T KNOW	145 40%	53 31%	92 47%	38 28%	107 47%	19 35%	41 34%	9 32%	76 46%

MCARTHUR ASSOCIATES
(503) 228-5565

4. CURRENTLY DO YOU THINK THERE ARE UNRESOLVED ISSUES WITH THE MANAGEMENT OF STORMWATER IN CORVALLIS?

CORVALLIS
STORMWATER SURVEY
JANUARY, 1998

		GENDER		AGE			EDUCATION			RESIDENCE		AREA				RESIDENCY	
	TOTAL	MALE	FEMALE	18-34	35-54	55PLUS	HIGH/ LESS	SOME COLLEG	COLLEG GRAD	OWN	RENT	NORTH EAST	NORTH WEST	SOUTH EAST	SOUTH WEST	<10YRS	10YRS>
TOTAL RESPONDENTS	366	184	182	100	158	102	62	105	195	230	129	34	217	27	75	176	188
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
YES	170	90	80	47	85	35	17	47	103	106	62	17	98	15	34	76	93
	46%	49%	44%	47%	54%	34%	27%	45%	53%	46%	48%	50%	45%	56%	45%	43%	49%
NO	89	49	40	25	29	33	18	24	46	56	31	5	58	7	17	45	44
	24%	27%	22%	25%	18%	32%	29%	23%	24%	24%	24%	15%	27%	26%	23%	26%	23%
DON'T KNOW	107	45	62	28	44	34	27	34	46	68	36	12	61	5	24	55	51
	29%	24%	34%	28%	28%	33%	44%	32%	24%	30%	28%	35%	28%	19%	32%	31%	27%

MCARTHUR ASSOCIATES
(503) 228-5565

4. CURRENTLY DO YOU THINK THERE ARE UNRESOLVED ISSUES WITH THE MANAGEMENT OF STORMWATER IN CORVALLIS?

		--UNRESOLVED-		-AFFEC FLOOD-		------STORMWATER BILL------			
	TOTAL	YES	NO/DK	YES	NO	HIGH	RIGHT	LOW	DK/NOP
TOTAL RESPONDENTS	366 100%	170 100%	196 100%	136 100%	230 100%	54 100%	120 100%	28 100%	164 100%
YES	170 46%	170 100%	0	73 54%	97 42%	30 56%	56 47%	15 54%	69 42%
NO	89 24%	0	89 45%	28 21%	61 27%	11 20%	29 24%	6 21%	43 26%
DON'T KNOW	107 29%	0	107 55%	35 26%	72 31%	13 24%	35 29%	7 25%	52 32%

5. PLEASE TELL ME WHETHER EROSION FROM CONSTRUCTION SITES IS VERY IMPORTANT, IMPORTANT, OR NOT IMPORTANT?

CORVALLIS
STORMWATER SURVEY
JANUARY, 1998

		GENDER		AGE			EDUCATION			RESIDENCE		AREA				RESIDENCY	
	TOTAL	MALE	FEMALE	18-34	35-54	55PLUS	HIGH/ LESS	SOME COLLEG	COLLEG GRAD	OWN	RENT	NORTH EAST	NORTH WEST	SOUTH EAST	SOUTH WEST	<10YRS	10YRS>
TOTAL RESPONDENTS	366	184	182	100	158	102	62	105	195	230	129	34	217	27	75	176	188
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
VERY IMPORTANT	148	58	90	42	64	39	20	51	74	95	50	17	84	10	32	70	77
	40%	32%	49%	42%	41%	38%	32%	49%	38%	41%	39%	50%	39%	37%	43%	40%	41%
IMPORTANT	166	91	75	46	76	42	32	40	94	102	60	10	110	10	31	85	81
	45%	49%	41%	46%	48%	41%	52%	38%	48%	44%	47%	29%	51%	37%	41%	48%	43%
NOT IMPORTANT	36	29	7	9	12	15	5	9	22	22	14	4	19	5	7	14	22
	10%	16%	4%	9%	8%	15%	8%	9%	11%	10%	11%	12%	9%	19%	9%	8%	12%
DON'T KNOW	16	6	10	3	6	6	5	5	5	11	5	3	4	2	5	7	8
	4%	3%	5%	3%	4%	6%	8%	5%	3%	5%	4%	9%	2%	7%	7%	4%	4%
TOTAL VERY IMPORTANT/IMPORTANT	314	149	165	88	140	81	52	91	168	197	110	27	194	20	63	155	158
	86%	81%	91%	88%	89%	79%	84%	87%	86%	86%	85%	79%	89%	74%	84%	88%	84%

MCARTHUR ASSOCIATES
(503) 228-5565

5. PLEASE TELL ME WHETHER EROSION FROM CONSTRUCTION SITES IS VERY IMPORTANT, IMPORTANT, OR NOT IMPORTANT?

		--UNRESOLVED-		-AFFEC FLOOD-		------STORMWATER BILL------			
	TOTAL	YES	NO/DK	YES	NO	HIGH	RIGHT	LOW	DK/NOP
TOTAL RESPONDENTS	366 100%	170 100%	196 100%	136 100%	230 100%	54 100%	120 100%	28 100%	164 100%
VERY IMPORTANT	148 40%	73 43%	75 38%	60 44%	88 38%	19 35%	53 44%	15 54%	61 37%
IMPORTANT	166 45%	73 43%	93 47%	57 42%	109 47%	25 46%	52 43%	11 39%	78 48%
NOT IMPORTANT	36 10%	15 9%	21 11%	13 10%	23 10%	9 17%	13 11%	2 7%	12 7%
DON'T KNOW	16 4%	9 5%	7 4%	6 4%	10 4%	1 2%	2 2%	0	13 8%
TOTAL VERY IMPORTANT/IMPORTANT	314 86%	146 86%	168 86%	117 86%	197 86%	44 81%	105 88%	26 93%	139 85%

MCARTHUR ASSOCIATES
(503) 228-5565

6. PLEASE TELL ME WHETHER EROSION ALONG STREAM BANKS IS VERY IMPORTANT, IMPORTANT, OR NOT IMPORTANT?

CORVALLIS
STORMWATER SURVEY
JANUARY, 1998

		GENDER		AGE			EDUCATION			RESIDENCE		AREA				RESIDENCY	
	TOTAL	MALE	FEMALE	18-34	35-54	55PLUS	HIGH/ LESS	SOME COLLEG	COLLEG GRAD	OWN	RENT	NORTH EAST	NORTH WEST	SOUTH EAST	SOUTH WEST	<10YRS	10YRS>
TOTAL RESPONDENTS	366 100%	184 100%	182 100%	100 100%	158 100%	102 100%	62 100%	105 100%	195 100%	230 100%	129 100%	34 100%	217 100%	27 100%	75 100%	176 100%	188 100%
VERY IMPORTANT	154 42%	69 38%	85 47%	50 50%	66 42%	32 31%	21 34%	51 49%	80 41%	95 41%	57 44%	18 53%	84 39%	14 52%	35 47%	74 42%	79 42%
IMPORTANT	165 45%	86 47%	79 43%	42 42%	74 47%	49 48%	35 56%	42 40%	86 44%	100 43%	60 47%	13 38%	104 48%	11 41%	30 40%	80 45%	85 45%
NOT IMPORTANT	37 10%	25 14%	12 7%	7 7%	15 9%	15 15%	5 8%	9 9%	23 12%	27 12%	10 8%	3 9%	24 11%	1 4%	7 9%	18 10%	19 10%
DON'T KNOW	10 3%	4 2%	6 3%	1 1%	3 2%	6 6%	1 2%	3 3%	6 3%	8 3%	2 2%	0	5 2%	1 4%	3 4%	4 2%	5 3%
TOTAL VERY IMPORTANT/IMPORTANT	319 87%	155 84%	164 90%	92 92%	140 89%	81 79%	56 90%	93 89%	166 85%	195 85%	117 91%	31 91%	188 87%	25 93%	65 87%	154 88%	164 87%

MCARTHUR ASSOCIATES
(503) 228-5565

6. PLEASE TELL ME WHETHER EROSION ALONG STREAM BANKS IS VERY IMPORTANT, IMPORTANT, OR NOT IMPORTANT?

		--UNRESOLVED-		-AFFEC FLOOD-		------STORMWATER BILL------			
	TOTAL	YES	NO/DK	YES	NO	HIGH	RIGHT	LOW	DK/NOP
TOTAL RESPONDENTS	366 100%	170 100%	196 100%	136 100%	230 100%	54 100%	120 100%	28 100%	164 100%
VERY IMPORTANT	154 42%	77 45%	77 39%	69 51%	85 37%	16 30%	56 47%	11 39%	71 43%
IMPORTANT	165 45%	76 45%	89 45%	58 43%	107 47%	31 57%	48 40%	14 50%	72 44%
NOT IMPORTANT	37 10%	11 6%	26 13%	6 4%	31 13%	5 9%	14 12%	3 11%	15 9%
DON'T KNOW	10 3%	6 4%	4 2%	3 2%	7 3%	2 4%	2 2%	0	6 4%
TOTAL VERY IMPORTANT/IMPORTANT	319 87%	153 90%	166 85%	127 93%	192 83%	47 87%	104 87%	25 89%	143 87%

MCARTHUR ASSOCIATES
(503) 228-5565

7. PLEASE TELL ME WHETHER SURFACE POLLUTANTS ENTERING STREAMS IS VERY IMPORTANT, IMPORTANT, OR NOT IMPORTANT?

CORVALLIS
STORMWATER SURVEY
JANUARY, 1998

		GENDER		AGE			EDUCATION			RESIDENCE		AREA				RESIDENCY	
	TOTAL	MALE	FEMALE	18-34	35-54	55PLUS	HIGH/ LESS	SOME COLLEG	COLLEG GRAD	OWN	RENT	NORTH EAST	NORTH WEST	SOUTH EAST	SOUTH WEST	<10YRS	10YRS>
TOTAL RESPONDENTS	366	184	182	100	158	102	62	105	195	230	129	34	217	27	75	176	188
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
VERY IMPORTANT	227	103	124	76	98	51	35	72	117	134	88	25	126	16	53	124	103
	62%	56%	68%	76%	62%	50%	56%	69%	60%	58%	68%	74%	58%	59%	71%	70%	55%
IMPORTANT	112	63	49	22	51	38	26	28	57	75	35	4	77	11	16	43	67
	31%	34%	27%	22%	32%	37%	42%	27%	29%	33%	27%	12%	35%	41%	21%	24%	36%
NOT IMPORTANT	16	13	3	2	6	7	0	2	14	13	3	3	8	0	4	5	11
	4%	7%	2%	2%	4%	7%		2%	7%	6%	2%	9%	4%		5%	3%	6%
DON'T KNOW	11	5	6	0	3	6	1	3	7	8	3	2	6	0	2	4	7
	3%	3%	3%		2%	6%	2%	3%	4%	3%	2%	6%	3%		3%	2%	4%
TOTAL VERY IMPORTANT/IMPORTANT	339	166	173	98	149	89	61	100	174	209	123	29	203	27	69	167	170
	93%	90%	95%	98%	94%	87%	98%	95%	89%	91%	95%	85%	94%	100%	92%	95%	90%

MCARTHUR ASSOCIATES
(503) 228-5565

7. PLEASE TELL ME WHETHER SURFACE POLLUTANTS ENTERING STREAMS IS VERY IMPORTANT, IMPORTANT, OR NOT IMPORTANT?

		--UNRESOLVED-		-AFFEC FLOOD-		------STORMWATER BILL------			
	TOTAL	YES	NO/DK	YES	NO	HIGH	RIGHT	LOW	DK/NOP
TOTAL RESPONDENTS	366 100%	170 100%	196 100%	136 100%	230 100%	54 100%	120 100%	28 100%	164 100%
VERY IMPORTANT	227 62%	109 64%	118 60%	87 64%	140 61%	22 41%	79 66%	22 79%	104 63%
IMPORTANT	112 31%	51 30%	61 31%	38 28%	74 32%	26 48%	35 29%	5 18%	46 28%
NOT IMPORTANT	16 4%	7 4%	9 5%	4 3%	12 5%	5 9%	4 3%	1 4%	6 4%
DON'T KNOW	11 3%	3 2%	8 4%	7 5%	4 2%	1 2%	2 2%	0	8 5%
TOTAL VERY IMPORTANT/IMPORTANT	339 93%	160 94%	179 91%	125 92%	214 93%	48 89%	114 95%	27 96%	150 91%

8. PLEASE TELL ME WHETHER LOSS OF STREAM HABITAT IS VERY IMPORTANT, IMPORTANT, OR NOT IMPORTANT?

CORVALLIS
STORMWATER SURVEY
JANUARY, 1998

		---GENDER----		--------AGE---------			------EDUCATION-----			--RESIDENCE--		-----------AREA-----------				--RESIDENCY--	
	TOTAL	MALE	FEMALE	18-34	35-54	55PLUS	HIGH/ LESS	SOME COLLEG	COLLEG GRAD	OWN	RENT	NORTH EAST	NORTH WEST	SOUTH EAST	SOUTH WEST	<10YRS	10YRS>
TOTAL RESPONDENTS	366 100%	184 100%	182 100%	100 100%	158 100%	102 100%	62 100%	105 100%	195 100%	230 100%	129 100%	34 100%	217 100%	27 100%	75 100%	176 100%	188 100%
VERY IMPORTANT	204 56%	93 51%	111 61%	73 73%	90 57%	37 36%	32 52%	68 65%	101 52%	116 50%	82 64%	24 71%	111 51%	15 56%	48 64%	112 64%	91 48%
IMPORTANT	119 33%	62 34%	57 31%	23 23%	56 35%	40 39%	24 39%	30 29%	64 33%	79 34%	39 30%	7 21%	76 35%	11 41%	20 27%	49 28%	69 37%
NOT IMPORTANT	33 9%	26 14%	7 4%	3 3%	9 6%	20 20%	5 8%	4 4%	24 12%	27 12%	6 5%	2 6%	24 11%	1 4%	5 7%	10 6%	23 12%
DON'T KNOW	10 3%	3 2%	7 4%	1 1%	3 2%	5 5%	1 2%	3 3%	6 3%	8 3%	2 2%	1 3%	6 3%	0	2 3%	5 3%	5 3%
TOTAL VERY IMPORTANT/IMPORTANT	323 88%	155 84%	168 92%	96 96%	146 92%	77 75%	56 90%	98 93%	165 85%	195 85%	121 94%	31 91%	187 86%	26 96%	68 91%	161 91%	160 85%

MCARTHUR ASSOCIATES
(503) 228-5565

8. PLEASE TELL ME WHETHER LOSS OF STREAM HABITAT IS VERY IMPORTANT, IMPORTANT, OR NOT IMPORTANT?

		--UNRESOLVED-		-AFFEC FLOOD-		------STORMWATER BILL------			
	TOTAL	YES	NO/DK	YES	NO	HIGH	RIGHT	LOW	DK/NOP
TOTAL RESPONDENTS	366 100%	170 100%	196 100%	136 100%	230 100%	54 100%	120 100%	28 100%	164 100%
VERY IMPORTANT	204 56%	97 57%	107 55%	79 58%	125 54%	19 35%	72 60%	16 57%	97 59%
IMPORTANT	119 33%	55 32%	64 33%	44 32%	75 33%	26 48%	32 27%	9 32%	52 32%
NOT IMPORTANT	33 9%	14 8%	19 10%	9 7%	24 10%	8 15%	15 13%	3 11%	7 4%
DON'T KNOW	10 3%	4 2%	6 3%	4 3%	6 3%	1 2%	1 1%	0	8 5%
TOTAL VERY IMPORTANT/IMPORTANT	323 88%	152 89%	171 87%	123 90%	200 87%	45 83%	104 87%	25 89%	149 91%

MCARTHUR ASSOCIATES
(503) 228-5565

9. PLEASE TELL ME WHETHER FLOODING OF STREETS, HOMES AND BUSINESSES IS VERY IMPORTANT, IMPORTANT, OR NOT IMPORTANT?

CORVALLIS
STORMWATER SURVEY
JANUARY, 1998

		---GENDER----		--------AGE---------			------EDUCATION-----			--RESIDENCE--		-----------AREA-----------				--RESIDENCY--	
	TOTAL	MALE	FEMALE	18-34	35-54	55PLUS	HIGH/ LESS	SOME COLLEG	COLLEG GRAD	OWN	RENT	NORTH EAST	NORTH WEST	SOUTH EAST	SOUTH WEST	<10YRS	10YRS>
TOTAL RESPONDENTS	366 100%	184 100%	182 100%	100 100%	158 100%	102 100%	62 100%	105 100%	195 100%	230 100%	129 100%	34 100%	217 100%	27 100%	75 100%	176 100%	188 100%
VERY IMPORTANT	208 57%	87 47%	121 66%	56 56%	96 61%	55 54%	38 61%	72 69%	96 49%	127 55%	78 60%	23 68%	129 59%	14 52%	39 52%	111 63%	97 52%
IMPORTANT	125 34%	74 40%	51 28%	39 39%	50 32%	32 31%	20 32%	28 27%	75 38%	76 33%	45 35%	9 26%	66 30%	12 44%	31 41%	52 30%	72 38%
NOT IMPORTANT	26 7%	20 11%	6 3%	4 4%	10 6%	12 12%	3 5%	4 4%	19 10%	21 9%	5 4%	2 6%	20 9%	1 4%	1 1%	10 6%	15 8%
DON'T KNOW	7 2%	3 2%	4 2%	1 1%	2 1%	3 3%	1 2%	1 1%	5 3%	6 3%	1 1%	0	2 1%	0	4 5%	3 2%	4 2%
TOTAL VERY IMPORTANT/IMPORTANT	333 91%	161 88%	172 95%	95 95%	146 92%	87 85%	58 94%	100 95%	171 88%	203 88%	123 95%	32 94%	195 90%	26 96%	70 93%	163 93%	169 90%

MCARTHUR ASSOCIATES
(503) 228-5565

9. PLEASE TELL ME WHETHER FLOODING OF STREETS, HOMES AND BUSINESSES IS VERY IMPORTANT, IMPORTANT, OR NOT IMPORTANT?

		--UNRESOLVED-		-AFFEC FLOOD-		------STORMWATER BILL------			
	TOTAL	YES	NO/DK	YES	NO	HIGH	RIGHT	LOW	DK/NOP
TOTAL RESPONDENTS	366 100%	170 100%	196 100%	136 100%	230 100%	54 100%	120 100%	28 100%	164 100%
VERY IMPORTANT	208 57%	97 57%	111 57%	94 69%	114 50%	28 52%	70 58%	17 61%	93 57%
IMPORTANT	125 34%	61 36%	64 33%	32 24%	93 40%	18 33%	37 31%	9 32%	61 37%
NOT IMPORTANT	26 7%	9 5%	17 9%	7 5%	19 8%	5 9%	12 10%	2 7%	7 4%
DON'T KNOW	7 2%	3 2%	4 2%	3 2%	4 2%	3 6%	1 1%	0	3 2%
TOTAL VERY IMPORTANT/IMPORTANT	333 91%	158 93%	175 89%	126 93%	207 90%	46 85%	107 89%	26 93%	154 94%

MCARTHUR ASSOCIATES
(503) 228-5565

10. PLEASE TELL ME WHETHER RAPID RUNOFF FROM NEW DEVELOPMENT IS VERY IMPORTANT, IMPORTANT, OR NOT IMPORTANT?

CORVALLIS
STORMWATER SURVEY
JANUARY, 1998

		GENDER		AGE			EDUCATION			RESIDENCE		AREA				RESIDENCY	
	TOTAL	MALE	FEMALE	18-34	35-54	55PLUS	HIGH/ LESS	SOME COLLEG	COLLEG GRAD	OWN	RENT	NORTH EAST	NORTH WEST	SOUTH EAST	SOUTH WEST	<10YRS	10YRS>
TOTAL RESPONDENTS	366 100%	184 100%	182 100%	100 100%	158 100%	102 100%	62 100%	105 100%	195 100%	230 100%	129 100%	34 100%	217 100%	27 100%	75 100%	176 100%	188 100%
VERY IMPORTANT	171 47%	75 41%	96 53%	43 43%	75 47%	48 47%	27 44%	52 50%	89 46%	119 52%	48 37%	20 59%	96 44%	14 52%	34 45%	85 48%	85 45%
IMPORTANT	145 40%	76 41%	69 38%	44 44%	66 42%	35 34%	26 42%	39 37%	79 41%	80 35%	62 48%	9 26%	97 45%	10 37%	27 36%	68 39%	77 41%
NOT IMPORTANT	35 10%	29 16%	6 3%	9 9%	12 8%	14 14%	4 6%	9 9%	22 11%	24 10%	11 9%	3 9%	19 9%	2 7%	10 13%	17 10%	18 10%
DON'T KNOW	15 4%	4 2%	11 6%	4 4%	5 3%	5 5%	5 8%	5 5%	5 3%	7 3%	8 6%	2 6%	5 2%	1 4%	4 5%	6 3%	8 4%
TOTAL VERY IMPORTANT/IMPORTANT	316 86%	151 82%	165 91%	87 87%	141 89%	83 81%	53 85%	91 87%	168 86%	199 87%	110 85%	29 85%	193 89%	24 89%	61 81%	153 87%	162 86%

MCARTHUR ASSOCIATES
(503) 228-5565

10. PLEASE TELL ME WHETHER RAPID RUNOFF FROM NEW DEVELOPMENT IS VERY IMPORTANT, IMPORTANT, OR NOT IMPORTANT?

		--UNRESOLVED-		-AFFEC FLOOD-		------STORMWATER BILL------			
	TOTAL	YES	NO/DK	YES	NO	HIGH	RIGHT	LOW	DK/NOP
TOTAL RESPONDENTS	366 100%	170 100%	196 100%	136 100%	230 100%	54 100%	120 100%	28 100%	164 100%
VERY IMPORTANT	171 47%	84 49%	87 44%	65 48%	106 46%	24 44%	59 49%	15 54%	73 45%
IMPORTANT	145 40%	68 40%	77 39%	55 40%	90 39%	25 46%	46 38%	11 39%	63 38%
NOT IMPORTANT	35 10%	15 9%	20 10%	8 6%	27 12%	4 7%	12 10%	2 7%	17 10%
DON'T KNOW	15 4%	3 2%	12 6%	8 6%	7 3%	1 2%	3 3%	0	11 7%
TOTAL VERY IMPORTANT/IMPORTANT	316 86%	152 89%	164 84%	120 88%	196 85%	49 91%	105 88%	26 93%	136 83%

11. PLEASE TELL ME WHETHER USE OF STREAMS TO DRAIN URBAN RUNOFF IS VERY IMPORTANT, IMPORTANT, OR NOT IMPORTANT?

CORVALLIS
STORMWATER SURVEY
JANUARY, 1998

		GENDER		AGE			EDUCATION			RESIDENCE		AREA				RESIDENCY	
	TOTAL	MALE	FEMALE	18-34	35-54	55PLUS	HIGH/ LESS	SOME COLLEG	COLLEG GRAD	OWN	RENT	NORTH EAST	NORTH WEST	SOUTH EAST	SOUTH WEST	<10YRS	10YRS>
TOTAL RESPONDENTS	366	184	182	100	158	102	62	105	195	230	129	34	217	27	75	176	188
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
VERY IMPORTANT	129	61	68	45	56	27	14	47	64	77	50	11	70	9	34	67	61
	35%	33%	37%	45%	35%	26%	23%	45%	33%	33%	39%	32%	32%	33%	45%	38%	32%
IMPORTANT	167	84	83	39	76	48	39	37	91	105	60	19	107	9	28	82	85
	46%	46%	46%	39%	48%	47%	63%	35%	47%	46%	47%	56%	49%	33%	37%	47%	45%
NOT IMPORTANT	37	25	12	12	14	11	6	7	24	22	13	0	27	4	5	18	19
	10%	14%	7%	12%	9%	11%	10%	7%	12%	10%	10%		12%	15%	7%	10%	10%
DON'T KNOW	33	14	19	4	12	16	3	14	16	26	6	4	13	5	8	9	23
	9%	8%	10%	4%	8%	16%	5%	13%	8%	11%	5%	12%	6%	19%	11%	5%	12%
TOTAL VERY IMPORTANT/IMPORTANT	296	145	151	84	132	75	53	84	155	182	110	30	177	18	62	149	146
	81%	79%	83%	84%	84%	74%	85%	80%	79%	79%	85%	88%	82%	67%	83%	85%	78%

MCARTHUR ASSOCIATES
(503) 228-5565

11. PLEASE TELL ME WHETHER USE OF STREAMS TO DRAIN URBAN RUNOFF IS VERY IMPORTANT, IMPORTANT, OR NOT IMPORTANT?

		--UNRESOLVED-		-AFFEC FLOOD-		------STORMWATER BILL------			
	TOTAL	YES	NO/DK	YES	NO	HIGH	RIGHT	LOW	DK/NOP
TOTAL RESPONDENTS	366 100%	170 100%	196 100%	136 100%	230 100%	54 100%	120 100%	28 100%	164 100%
VERY IMPORTANT	129 35%	71 42%	58 30%	58 43%	71 31%	14 26%	44 37%	10 36%	61 37%
IMPORTANT	167 46%	72 42%	95 48%	50 37%	117 51%	27 50%	53 44%	15 54%	72 44%
NOT IMPORTANT	37 10%	15 9%	22 11%	14 10%	23 10%	5 9%	17 14%	1 4%	14 9%
DON'T KNOW	33 9%	12 7%	21 11%	14 10%	19 8%	8 15%	6 5%	2 7%	17 10%
TOTAL VERY IMPORTANT/IMPORTANT	296 81%	143 84%	153 78%	108 79%	188 82%	41 76%	97 81%	25 89%	133 81%

MCARTHUR ASSOCIATES
(503) 228-5565

12. PLEASE TELL ME WHETHER DEVELOPMENT IN FLOOD PLAINS IS VERY IMPORTANT, IMPORTANT, OR NOT IMPORTANT?

CORVALLIS
STORMWATER SURVEY
JANUARY, 1998

		---GENDER----		--------AGE---------			------EDUCATION-----			--RESIDENCE--		-----------AREA-----------				--RESIDENCY--	
	TOTAL	MALE	FEMALE	18-34	35-54	55PLUS	HIGH/ LESS	SOME COLLEG	COLLEG GRAD	OWN	RENT	NORTH EAST	NORTH WEST	SOUTH EAST	SOUTH WEST	<10YRS	10YRS>
TOTAL RESPONDENTS	366 100%	184 100%	182 100%	100 100%	158 100%	102 100%	62 100%	105 100%	195 100%	230 100%	129 100%	34 100%	217 100%	27 100%	75 100%	176 100%	188 100%
VERY IMPORTANT	194 53%	98 53%	96 53%	52 52%	91 58%	47 46%	28 45%	56 53%	106 54%	123 53%	66 51%	18 53%	113 52%	11 41%	44 59%	100 57%	93 49%
IMPORTANT	114 31%	55 30%	59 32%	37 37%	44 28%	32 31%	22 35%	32 30%	60 31%	66 29%	46 36%	6 18%	81 37%	10 37%	16 21%	54 31%	60 32%
NOT IMPORTANT	34 9%	22 12%	12 7%	6 6%	14 9%	14 14%	6 10%	10 10%	18 9%	25 11%	9 7%	4 12%	19 9%	5 19%	5 7%	16 9%	18 10%
DON'T KNOW	24 7%	9 5%	15 8%	5 5%	9 6%	9 9%	6 10%	7 7%	11 6%	16 7%	8 6%	6 18%	4 2%	1 4%	10 13%	6 3%	17 9%
TOTAL VERY IMPORTANT/IMPORTANT	308 84%	153 83%	155 85%	89 89%	135 85%	79 77%	50 81%	88 84%	166 85%	189 82%	112 87%	24 71%	194 89%	21 78%	60 80%	154 88%	153 81%

MCARTHUR ASSOCIATES
(503) 228-5565

12. PLEASE TELL ME WHETHER DEVELOPMENT IN FLOOD PLAINS IS VERY IMPORTANT, IMPORTANT, OR NOT IMPORTANT?

		--UNRESOLVED-		-AFFEC FLOOD-		------STORMWATER BILL------			
	TOTAL	YES	NO/DK	YES	NO	HIGH	RIGHT	LOW	DK/NOP
TOTAL RESPONDENTS	366 100%	170 100%	196 100%	136 100%	230 100%	54 100%	120 100%	28 100%	164 100%
VERY IMPORTANT	194 53%	96 56%	98 50%	77 57%	117 51%	22 41%	66 55%	18 64%	88 54%
IMPORTANT	114 31%	47 28%	67 34%	38 28%	76 33%	22 41%	39 33%	6 21%	47 29%
NOT IMPORTANT	34 9%	14 8%	20 10%	12 9%	22 10%	7 13%	9 8%	3 11%	15 9%
DON'T KNOW	24 7%	13 8%	11 6%	9 7%	15 7%	3 6%	6 5%	1 4%	14 9%
TOTAL VERY IMPORTANT/IMPORTANT	308 84%	143 84%	165 84%	115 85%	193 84%	44 81%	105 88%	24 86%	135 82%

MCARTHUR ASSOCIATES
(503) 228-5565

13. WHAT DO YOU THINK HAS HELPED TO CAUSE THE FLOODING IN THE CORVALLIS COMMUNITY DURING THE PAST FEW YEARS? (MULTIPLE RESPONSE)

CORVALLIS
STORMWATER SURVEY
JANUARY, 1998

		---GENDER----		--------AGE---------			------EDUCATION-----			--RESIDENCE--		-----------AREA-----------				--RESIDENCY--	
	TOTAL	MALE	FEMALE	18-34	35-54	55PLUS	HIGH/ LESS	SOME COLLEG	COLLEG GRAD	OWN	RENT	NORTH EAST	NORTH WEST	SOUTH EAST	SOUTH WEST	<10YRS	10YRS>
TOTAL RESPONDENTS	366	184	182	100	158	102	62	105	195	230	129	34	217	27	75	176	188
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
TOO MUCH RAINFALL	125	79	46	24	60	41	17	34	73	85	37	5	81	11	25	48	77
	34%	43%	25%	24%	38%	40%	27%	32%	37%	37%	29%	15%	37%	41%	33%	27%	41%
NEW/TOO MUCH/UPSTREAM DEVELOPMENT	112	52	60	24	54	31	15	31	65	78	33	10	72	9	18	40	72
	31%	28%	33%	24%	34%	30%	24%	30%	33%	34%	26%	29%	33%	33%	24%	23%	38%
POOR DEVELOPMENT STANDARDS/NOT ENFORCED	80	33	47	23	37	17	9	25	44	48	31	6	51	6	15	37	42
	22%	18%	26%	23%	23%	17%	15%	24%	23%	21%	24%	18%	24%	22%	20%	21%	22%
CLOGGED STREET GUTTER OR CATCH BASIN	51	21	30	19	24	6	7	17	27	27	23	4	31	6	7	23	28
	14%	11%	16%	19%	15%	6%	11%	16%	14%	12%	18%	12%	14%	22%	9%	13%	15%
DEVELOPMENT IN FLOOD PLAINS	51	24	27	13	23	13	7	14	30	34	16	7	31	2	9	22	29
	14%	13%	15%	13%	15%	13%	11%	13%	15%	15%	12%	21%	14%	7%	12%	13%	15%
STREAM OVERFLOWING BANKS	38	19	19	8	17	13	7	12	19	30	8	6	23	2	7	14	24
	10%	10%	10%	8%	11%	13%	11%	11%	10%	13%	6%	18%	11%	7%	9%	8%	13%
INADEQUATE SEWER/DRAINAGE SYSTEM/PIPES	18	10	8	2	12	4	3	4	11	11	7	0	12	2	4	7	11
	5%	5%	4%	2%	8%	4%	5%	4%	6%	5%	5%		6%	7%	5%	4%	6%
STREAM OVERFLOWING AT CULVERT UNDER STREET	9	5	4	4	4	1	1	2	6	5	4	1	4	2	1	4	5
	2%	3%	2%	4%	3%	1%	2%	2%	3%	2%	3%	3%	2%	7%	1%	2%	3%
EXCESS/EARLY/TOO MUCH/SNOW MELT	9	5	4	2	5	2	1	4	4	8	1	0	6	0	3	4	5
	2%	3%	2%	2%	3%	2%	2%	4%	2%	3%	1%		3%		4%	2%	3%
TOO MUCH LOGGING/CLEARCUTTING	8	6	2	3	3	2	0	1	7	4	4	0	4	0	2	4	4
	2%	3%	1%	3%	2%	2%		1%	4%	2%	3%		2%		3%	2%	2%
TOO MUCH PAVEMENT/CONCRETE/ ROAD SURFACE	8	3	5	0	3	3	0	2	5	5	2	1	3	0	3	1	6
	2%	2%	3%		2%	3%		2%	3%	2%	2%	3%	1%		4%	1%	3%
TOO MANY PEOPLE/POPULATION GROWTH/OVERPOPULATION	7	4	3	1	4	1	1	2	4	5	2	2	3	2	0	2	5
	2%	2%	2%	1%	3%	1%	2%	2%	2%	2%	2%	6%	1%	7%		1%	3%

13. WHAT DO YOU THINK HAS HELPED TO CAUSE THE FLOODING IN THE CORVALLIS COMMUNITY DURING THE PAST FEW YEARS? (MULTIPLE RESPONSE)

		--UNRESOLVED-		-AFFEC FLOOD-		------STORMWATER BILL------			
	TOTAL	YES	NO/DK	YES	NO	HIGH	RIGHT	LOW	DK/NOP
TOTAL RESPONDENTS	366 100%	170 100%	196 100%	136 100%	230 100%	54 100%	120 100%	28 100%	164 100%
TOO MUCH RAINFALL	125 34%	50 29%	75 38%	45 33%	80 35%	16 30%	49 41%	11 39%	49 30%
NEW/TOO MUCH/UPSTREAM DEVELOPMENT	112 31%	70 41%	42 21%	46 34%	66 29%	19 35%	45 38%	11 39%	37 23%
POOR DEVELOPMENT STANDARDS/NOT ENFORCED	80 22%	60 35%	20 10%	39 29%	41 18%	13 24%	33 28%	7 25%	27 16%
CLOGGED STREET GUTTER OR CATCH BASIN	51 14%	29 17%	22 11%	33 24%	18 8%	6 11%	14 12%	5 18%	26 16%
DEVELOPMENT IN FLOOD PLAINS	51 14%	29 17%	22 11%	19 14%	32 14%	5 9%	19 16%	3 11%	24 15%
STREAM OVERFLOWING BANKS	38 10%	15 9%	23 12%	18 13%	20 9%	6 11%	10 8%	5 18%	17 10%
INADEQUATE SEWER/DRAINAGE SYSTEM/PIPES	18 5%	13 8%	5 3%	9 7%	9 4%	4 7%	9 8%	0	5 3%
STREAM OVERFLOWING AT CULVERT UNDER STREET	9 2%	6 4%	3 2%	7 5%	2 1%	1 2%	4 3%	1 4%	3 2%
EXCESS/EARLY/TOO MUCH/SNOW MELT	9 2%	3 2%	6 3%	6 4%	3 1%	4 7%	2 2%	0	3 2%
TOO MUCH LOGGING/CLEARCUTTING	8 2%	6 4%	2 1%	3 2%	5 2%	0	2 2%	0	6 4%
TOO MUCH PAVEMENT/CONCRETE/ ROAD SURFACE	8 2%	5 3%	3 2%	5 4%	3 1%	1 2%	3 3%	2 7%	2 1%
TOO MANY PEOPLE/POPULATION GROWTH/OVERPOPULATION	7 2%	3 2%	4 2%	3 2%	4 2%	1 2%	4 3%	0	2 1%

MCARTHUR ASSOCIATES
(503) 228-5565

13. WHAT DO YOU THINK HAS HELPED TO CAUSE THE FLOODING IN THE CORVALLIS COMMUNITY DURING THE PAST FEW YEARS? (MULTIPLE RESPONSE)

CORVALLIS
STORMWATER SURVEY
JANUARY, 1998

		---GENDER----		--------AGE---------			------EDUCATION-----			--RESIDENCE--		-----------AREA------------				--RESIDENCY--	
	TOTAL	MALE	FEMALE	18-34	35-54	55PLUS	HIGH/ LESS	SOME COLLEG	COLLEG GRAD	OWN	RENT	NORTH EAST	NORTH WEST	SOUTH EAST	SOUTH WEST	<10YRS	10YRS>
TOTAL RESPONDENTS	366	184	182	100	158	102	62	105	195	230	129	34	217	27	75	176	188
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
STREAM DEBRIS	6	3	3	3	2	1	1	2	3	3	3	0	4	1	1	4	2
	2%	2%	2%	3%	1%	1%	2%	2%	2%	1%	2%		2%	4%	1%	2%	1%
STORMS/WEATHER PATTERNS/ CYCLES/EL NINO	5	2	3	0	4	1	0	1	4	4	1	0	3	0	1	3	2
	1%	1%	2%		3%	1%		1%	2%	2%	1%		1%		1%	2%	1%
EROSION	4	3	1	2	2	0	1	3	0	1	3	0	3	1	0	2	2
	1%	2%	1%	2%	1%		2%	3%		*	2%		1%	4%		1%	1%
FLOW COMING OUT OF MANHOLE	3	3	0	2	1	0	0	2	1	1	2	0	2	0	0	1	2
	1%	2%		2%	1%			2%	1%	*	2%		1%			1%	1%
DON'T KNOW	60	16	44	25	17	18	21	18	20	31	27	9	26	4	18	44	15
	16%	9%	24%	25%	11%	18%	34%	17%	10%	13%	21%	26%	12%	15%	24%	25%	8%

13. WHAT DO YOU THINK HAS HELPED TO CAUSE THE FLOODING IN THE CORVALLIS COMMUNITY DURING THE PAST FEW YEARS? (MULTIPLE RESPONSE)

		--UNRESOLVED-		-AFFEC FLOOD-		------STORMWATER BILL------			
	TOTAL	YES	NO/DK	YES	NO	HIGH	RIGHT	LOW	DK/NOP
TOTAL RESPONDENTS	366 100%	170 100%	196 100%	136 100%	230 100%	54 100%	120 100%	28 100%	164 100%
STREAM DEBRIS	6 2%	3 2%	3 2%	5 4%	1 *	3 6%	1 1%	2 7%	0
STORMS/WEATHER PATTERNS/ CYCLES/EL NINO	5 1%	2 1%	3 2%	4 3%	1 *	0	2 2%	0	3 2%
EROSION	4 1%	3 2%	1 1%	3 2%	1 *	2 4%	1 1%	0	1 1%
FLOW COMING OUT OF MANHOLE	3 1%	3 2%	0	2 1%	1 *	0	0	0	3 2%
DON'T KNOW	60 16%	13 8%	47 24%	9 7%	51 22%	8 15%	11 9%	4 14%	37 23%

MCARTHUR ASSOCIATES
(503) 228-5565

14. HAVE YOU BEEN AFFECTED BY THE FLOODING IN CORVALLIS?

CORVALLIS
STORMWATER SURVEY
JANUARY, 1998

		---GENDER----		--------AGE---------			------EDUCATION-----			--RESIDENCE--		-----------AREA-----------				--RESIDENCY--	
	TOTAL	MALE	FEMALE	18-34	35-54	55PLUS	HIGH/ LESS	SOME COLLEG	COLLEG GRAD	OWN	RENT	NORTH EAST	NORTH WEST	SOUTH EAST	SOUTH WEST	<10YRS	10YRS>
TOTAL RESPONDENTS	366	184	182	100	158	102	62	105	195	230	129	34	217	27	75	176	188
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
YES	136	62	74	40	62	29	12	51	72	83	49	12	71	21	26	55	80
	37%	34%	41%	40%	39%	28%	19%	49%	37%	36%	38%	35%	33%	78%	35%	31%	43%
NO	230	122	108	60	96	73	50	54	123	147	80	22	146	6	49	121	108
	63%	66%	59%	60%	61%	72%	81%	51%	63%	64%	62%	65%	67%	22%	65%	69%	57%

MCARTHUR ASSOCIATES
(503) 228-5565

14. HAVE YOU BEEN AFFECTED BY THE FLOODING IN CORVALLIS?

		--UNRESOLVED-		-AFFEC FLOOD-		------STORMWATER BILL------			
	TOTAL	YES	NO/DK	YES	NO	HIGH	RIGHT	LOW	DK/NOP
TOTAL RESPONDENTS	366 100%	170 100%	196 100%	136 100%	230 100%	54 100%	120 100%	28 100%	164 100%
YES	136 37%	73 43%	63 32%	136 100%	0	19 35%	48 40%	13 46%	56 34%
NO	230 63%	97 57%	133 68%	0	230 100%	35 65%	72 60%	15 54%	108 66%

MCARTHUR ASSOCIATES
(503) 228-5565

15. HOW HAS FLOODING AFFECTED YOU? (MULTIPLE RESPONSE)

CORVALLIS
STORMWATER SURVEY
JANUARY, 1998

		GENDER		AGE			EDUCATION			RESIDENCE		AREA				RESIDENCY	
	TOTAL	MALE	FEMALE	18-34	35-54	55PLUS	HIGH/ LESS	SOME COLLEG	COLLEG GRAD	OWN	RENT	NORTH EAST	NORTH WEST	SOUTH EAST	SOUTH WEST	<10YRS	10YRS>
TOTAL RESPONDENTS	366	184	182	100	158	102	62	105	195	230	129	34	217	27	75	176	188
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE:	136	62	74	40	62	29	12	51	72	83	49	12	71	21	26	55	80
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
RESTRICTED ACCESS TO HOME OR WORKPLACE	65	32	33	21	36	7	5	28	31	38	26	4	34	15	9	25	39
	48%	52%	45%	53%	58%	24%	42%	55%	43%	46%	53%	33%	48%	71%	35%	45%	49%
FLOODED STREETS	57	26	31	13	29	14	5	21	30	35	20	4	27	13	12	19	37
	42%	42%	42%	33%	47%	48%	42%	41%	42%	42%	41%	33%	38%	62%	46%	35%	46%
FLOODED YARD OR DRIVEWAY	30	13	17	7	11	11	3	12	15	21	7	5	12	4	7	12	18
	22%	21%	23%	18%	18%	38%	25%	24%	21%	25%	14%	42%	17%	19%	27%	22%	23%
FLOODED BASEMENT/GARAGE OR CRAWL SPACE	23	7	16	10	8	4	2	6	15	15	7	0	18	2	2	13	10
	17%	11%	22%	25%	13%	14%	17%	12%	21%	18%	14%		25%	10%	8%	24%	13%
RESTRICTED/DIFFICULT TRANSPORTATION	10	4	6	3	4	1	1	2	6	1	8	1	7	0	1	5	4
	7%	6%	8%	8%	6%	3%	8%	4%	8%	1%	16%	8%	10%		4%	9%	5%
FLOODED FIRST FLOOR	7	3	4	3	0	2	0	4	3	5	2	1	2	1	2	2	5
	5%	5%	5%	8%		7%		8%	4%	6%	4%	8%	3%	5%	8%	4%	6%
WATER SERVICE WAS SHUT OFF	1	0	1	1	0	0	0	1	0	0	1	1	0	0	0	1	0
	1%		1%	3%				2%			2%	8%				2%	

15. HOW HAS FLOODING AFFECTED YOU? (MULTIPLE RESPONSE)

		--UNRESOLVED-		-AFFEC FLOOD-		------STORMWATER BILL------			
	TOTAL	YES	NO/DK	YES	NO	HIGH	RIGHT	LOW	DK/NOP
TOTAL RESPONDENTS	366 100%	170 100%	196 100%	136 100%	230 100%	54 100%	120 100%	28 100%	164 100%
BASE:	136 100%	73 100%	63 100%	136 100%	0	19 100%	48 100%	13 100%	56 100%
RESTRICTED ACCESS TO HOME OR WORKPLACE	65 48%	38 52%	27 43%	65 48%	0	15 79%	19 40%	6 46%	25 45%
FLOODED STREETS	57 42%	33 45%	24 38%	57 42%	0	11 58%	17 35%	6 46%	23 41%
FLOODED YARD OR DRIVEWAY	30 22%	17 23%	13 21%	30 22%	0	4 21%	10 21%	3 23%	13 23%
FLOODED BASEMENT/GARAGE OR CRAWL SPACE	23 17%	11 15%	12 19%	23 17%	0	3 16%	11 23%	2 15%	7 13%
RESTRICTED/DIFFICULT TRANSPORTATION	10 7%	7 10%	3 5%	10 7%	0	1 5%	2 4%	1 8%	6 11%
FLOODED FIRST FLOOR	7 5%	6 8%	1 2%	7 5%	0	1 5%	2 4%	1 8%	3 5%
WATER SERVICE WAS SHUT OFF	1 1%	0	1 2%	1 1%	0	0	0	0	1 2%

MCARTHUR ASSOCIATES
(503) 228-5565

16. HOW OFTEN HAS FLOODING AFFECTED YOU IN THE LAST TWO YEARS?

CORVALLIS
STORMWATER SURVEY
JANUARY, 1998

		GENDER		AGE			EDUCATION			RESIDENCE		AREA				RESIDENCY	
	TOTAL	MALE	FEMALE	18-34	35-54	55PLUS	HIGH/ LESS	SOME COLLEG	COLLEG GRAD	OWN	RENT	NORTH EAST	NORTH WEST	SOUTH EAST	SOUTH WEST	<10YRS	10YRS>
TOTAL RESPONDENTS	366	184	182	100	158	102	62	105	195	230	129	34	217	27	75	176	188
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE:	136	62	74	40	62	29	12	51	72	83	49	12	71	21	26	55	80
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
TWO OR MORE EVENTS PER YEAR	55	21	34	22	21	10	4	21	30	27	28	7	25	5	14	28	27
	40%	34%	46%	55%	34%	34%	33%	41%	42%	33%	57%	58%	35%	24%	54%	51%	34%
ONE EVENT PER YEAR	52	28	24	14	26	10	5	22	24	35	14	3	28	14	6	17	34
	38%	45%	32%	35%	42%	34%	42%	43%	33%	42%	29%	25%	39%	67%	23%	31%	43%
LESS THAN ONE EVENT PER YEAR	20	11	9	4	10	6	2	6	12	13	6	2	12	0	5	7	13
	15%	18%	12%	10%	16%	21%	17%	12%	17%	16%	12%	17%	17%		19%	13%	16%
DON'T KNOW/NOT SURE	9	2	7	0	5	3	1	2	6	8	1	0	6	2	1	3	6
	7%	3%	9%		8%	10%	8%	4%	8%	10%	2%		8%	10%	4%	5%	8%

16. HOW OFTEN HAS FLOODING AFFECTED YOU IN THE LAST TWO YEARS?

	TOTAL	--UNRESOLVED- YES	NO/DK	-AFFEC FLOOD- YES	NO	------STORMWATER BILL------ HIGH	RIGHT	LOW	DK/NOP
TOTAL RESPONDENTS	366 100%	170 100%	196 100%	136 100%	230 100%	54 100%	120 100%	28 100%	164 100%
BASE:	136 100%	73 100%	63 100%	136 100%	0	19 100%	48 100%	13 100%	56 100%
TWO OR MORE EVENTS PER YEAR	55 40%	35 48%	20 32%	55 40%	0	5 26%	20 42%	5 38%	25 45%
ONE EVENT PER YEAR	52 38%	24 33%	28 44%	52 38%	0	10 53%	20 42%	6 46%	16 29%
LESS THAN ONE EVENT PER YEAR	20 15%	9 12%	11 17%	20 15%	0	1 5%	7 15%	1 8%	11 20%
DON'T KNOW/NOT SURE	9 7%	5 7%	4 6%	9 7%	0	3 16%	1 2%	1 8%	4 7%

MCARTHUR ASSOCIATES
(503) 228-5565

17. PLEASE TELL ME WHETHER IMPROVING STREAM WATER QUALITY IS VERY IMPORTANT, IMPORTANT, OR NOT IMPORTANT IN PLANNING FUTURE COMMUNITY STORMWATER MANAGEMENT?

CORVALLIS
STORMWATER SURVEY
JANUARY, 1998

		GENDER		AGE			EDUCATION			RESIDENCE		AREA				RESIDENCY	
	TOTAL	MALE	FEMALE	18-34	35-54	55PLUS	HIGH/ LESS	SOME COLLEG	COLLEG GRAD	OWN	RENT	NORTH EAST	NORTH WEST	SOUTH EAST	SOUTH WEST	<10YRS	10YRS>
TOTAL RESPONDENTS	366 100%	184 100%	182 100%	100 100%	158 100%	102 100%	62 100%	105 100%	195 100%	230 100%	129 100%	34 100%	217 100%	27 100%	75 100%	176 100%	188 100%
VERY IMPORTANT	191 52%	90 49%	101 55%	62 62%	89 56%	36 35%	27 44%	60 57%	101 52%	110 48%	76 59%	21 62%	106 49%	14 52%	45 60%	102 58%	88 47%
IMPORTANT	151 41%	78 42%	73 40%	33 33%	58 37%	59 58%	33 53%	34 32%	83 43%	105 46%	45 35%	10 29%	101 47%	13 48%	23 31%	65 37%	86 46%
NOT IMPORTANT	16 4%	13 7%	3 2%	3 3%	8 5%	5 5%	1 2%	6 6%	9 5%	10 4%	6 5%	1 3%	9 4%	0	6 8%	8 5%	8 4%
DON'T KNOW	8 2%	3 2%	5 3%	2 2%	3 2%	2 2%	1 2%	5 5%	2 1%	5 2%	2 2%	2 6%	1 *	0	1 1%	1 1%	6 3%
TOTAL VERY IMPORTANT/IMPORTANT	342 93%	168 91%	174 96%	95 95%	147 93%	95 93%	60 97%	94 90%	184 94%	215 93%	121 94%	31 91%	207 95%	27 100%	68 91%	167 95%	174 93%

MCARTHUR ASSOCIATES
(503) 228-5565

17. PLEASE TELL ME WHETHER IMPROVING STREAM WATER QUALITY IS VERY IMPORTANT, IMPORTANT, OR NOT IMPORTANT IN PLANNING FUTURE COMMUNITY STORMWATER MANAGEMENT?

		--UNRESOLVED-		-AFFEC FLOOD-		------STORMWATER BILL------			
	TOTAL	YES	NO/DK	YES	NO	HIGH	RIGHT	LOW	DK/NOP
TOTAL RESPONDENTS	366 100%	170 100%	196 100%	136 100%	230 100%	54 100%	120 100%	28 100%	164 100%
VERY IMPORTANT	191 52%	98 58%	93 47%	77 57%	114 50%	19 35%	68 57%	15 54%	89 54%
IMPORTANT	151 41%	61 36%	90 46%	49 36%	102 44%	30 56%	49 41%	12 43%	60 37%
NOT IMPORTANT	16 4%	8 5%	8 4%	6 4%	10 4%	5 9%	1 1%	1 4%	9 5%
DON'T KNOW	8 2%	3 2%	5 3%	4 3%	4 2%	0	2 2%	0	6 4%
TOTAL VERY IMPORTANT/IMPORTANT	342 93%	159 94%	183 93%	126 93%	216 94%	49 91%	117 98%	27 96%	149 91%

MCARTHUR ASSOCIATES
(503) 228-5565

18. PLEASE TELL ME WHETHER INCREASING STREAM CORRIDOR WIDTHS IS VERY IMPORTANT, IMPORTANT, OR NOT IMPORTANT IN PLANNING FUTURE COMMUNITY STORMWATER MANAGEMENT?

CORVALLIS
STORMWATER SURVEY
JANUARY, 1998

		---GENDER----		--------AGE---------			------EDUCATION-----			--RESIDENCE--		-----------AREA------------				--RESIDENCY--	
	TOTAL	MALE	FEMALE	18-34	35-54	55PLUS	HIGH/ LESS	SOME COLLEG	COLLEG GRAD	OWN	RENT	NORTH EAST	NORTH WEST	SOUTH EAST	SOUTH WEST	<10YRS	10YRS>
TOTAL RESPONDENTS	366 100%	184 100%	182 100%	100 100%	158 100%	102 100%	62 100%	105 100%	195 100%	230 100%	129 100%	34 100%	217 100%	27 100%	75 100%	176 100%	188 100%
VERY IMPORTANT	58 16%	28 15%	30 16%	19 19%	27 17%	11 11%	11 18%	15 14%	32 16%	33 14%	25 19%	6 18%	33 15%	6 22%	13 17%	30 17%	28 15%
IMPORTANT	185 51%	97 53%	88 48%	55 55%	74 47%	54 53%	31 50%	55 52%	96 49%	114 50%	66 51%	14 41%	114 53%	13 48%	36 48%	89 51%	95 51%
NOT IMPORTANT	71 19%	41 22%	30 16%	18 18%	34 22%	19 19%	10 16%	16 15%	44 23%	51 22%	19 15%	2 6%	48 22%	5 19%	14 19%	35 20%	36 19%
DON'T KNOW	52 14%	18 10%	34 19%	8 8%	23 15%	18 18%	10 16%	19 18%	23 12%	32 14%	19 15%	12 35%	22 10%	3 11%	12 16%	22 13%	29 15%
TOTAL VERY IMPORTANT/IMPORTANT	243 66%	125 68%	118 65%	74 74%	101 64%	65 64%	42 68%	70 67%	128 66%	147 64%	91 71%	20 59%	147 68%	19 70%	49 65%	119 68%	123 65%

18. PLEASE TELL ME WHETHER INCREASING STREAM CORRIDOR WIDTHS IS VERY IMPORTANT, IMPORTANT, OR NOT IMPORTANT IN PLANNING FUTURE COMMUNITY STORMWATER MANAGEMENT?

		--UNRESOLVED-		-AFFEC FLOOD-		------STORMWATER BILL------			
	TOTAL	YES	NO/DK	YES	NO	HIGH	RIGHT	LOW	DK/NOP
TOTAL RESPONDENTS	366 100%	170 100%	196 100%	136 100%	230 100%	54 100%	120 100%	28 100%	164 100%
VERY IMPORTANT	58 16%	36 21%	22 11%	27 20%	31 13%	9 17%	19 16%	6 21%	24 15%
IMPORTANT	185 51%	86 51%	99 51%	63 46%	122 53%	31 57%	68 57%	13 46%	73 45%
NOT IMPORTANT	71 19%	27 16%	44 22%	26 19%	45 20%	11 20%	21 18%	7 25%	32 20%
DON'T KNOW	52 14%	21 12%	31 16%	20 15%	32 14%	3 6%	12 10%	2 7%	35 21%
TOTAL VERY IMPORTANT/IMPORTANT	243 66%	122 72%	121 62%	90 66%	153 67%	40 74%	87 73%	19 68%	97 59%

MCARTHUR ASSOCIATES
(503) 228-5565

19. PLEASE TELL ME WHETHER PREVENTING FLOOD DAMAGE TO STREETS AND PROPERTY IS VERY IMPORTANT, IMPORTANT, OR NOT IMPORTANT IN PLANNING FUTURE COMMUNITY STORMWATER MANAGEMENT?

CORVALLIS
STORMWATER SURVEY
JANUARY, 1998

		GENDER		AGE			EDUCATION			RESIDENCE		AREA				RESIDENCY	
	TOTAL	MALE	FEMALE	18-34	35-54	55PLUS	HIGH/ LESS	SOME COLLEG	COLLEG GRAD	OWN	RENT	NORTH EAST	NORTH WEST	SOUTH EAST	SOUTH WEST	<10YRS	10YRS>
TOTAL RESPONDENTS	366 100%	184 100%	182 100%	100 100%	158 100%	102 100%	62 100%	105 100%	195 100%	230 100%	129 100%	34 100%	217 100%	27 100%	75 100%	176 100%	188 100%
VERY IMPORTANT	175 48%	78 42%	97 53%	51 51%	69 44%	52 51%	34 55%	54 51%	85 44%	105 46%	65 50%	22 65%	108 50%	11 41%	28 37%	97 55%	78 41%
IMPORTANT	172 47%	96 52%	76 42%	47 47%	77 49%	46 45%	27 44%	46 44%	97 50%	111 48%	59 46%	11 32%	100 46%	14 52%	42 56%	72 41%	98 52%
NOT IMPORTANT	14 4%	9 5%	5 3%	2 2%	8 5%	4 4%	1 2%	4 4%	9 5%	9 4%	5 4%	1 3%	8 4%	1 4%	4 5%	5 3%	9 5%
DON'T KNOW	5 1%	1 1%	4 2%	0	4 3%	0	0	1 1%	4 2%	5 2%	0	0	1 *	1 4%	1 1%	2 1%	3 2%
TOTAL VERY IMPORTANT/IMPORTANT	347 95%	174 95%	173 95%	98 98%	146 92%	98 96%	61 98%	100 95%	182 93%	216 94%	124 96%	33 97%	208 96%	25 93%	70 93%	169 96%	176 94%

MCARTHUR ASSOCIATES
(503) 228-5565

19. PLEASE TELL ME WHETHER PREVENTING FLOOD DAMAGE TO STREETS AND PROPERTY IS VERY IMPORTANT, IMPORTANT, OR NOT IMPORTANT IN PLANNING FUTURE COMMUNITY STORMWATER MANAGEMENT?

		--UNRESOLVED-		-AFFEC FLOOD-		------STORMWATER BILL------			
	TOTAL	YES	NO/DK	YES	NO	HIGH	RIGHT	LOW	DK/NOP
TOTAL RESPONDENTS	366 100%	170 100%	196 100%	136 100%	230 100%	54 100%	120 100%	28 100%	164 100%
VERY IMPORTANT	175 48%	88 52%	87 44%	75 55%	100 43%	32 59%	60 50%	10 36%	73 45%
IMPORTANT	172 47%	75 44%	97 49%	55 40%	117 51%	17 31%	57 48%	16 57%	82 50%
NOT IMPORTANT	14 4%	7 4%	7 4%	2 1%	12 5%	4 7%	2 2%	2 7%	6 4%
DON'T KNOW	5 1%	0	5 3%	4 3%	1 *	1 2%	1 1%	0	3 2%
TOTAL VERY IMPORTANT/IMPORTANT	347 95%	163 96%	184 94%	130 96%	217 94%	49 91%	117 98%	26 93%	155 95%

MCARTHUR ASSOCIATES
(503) 228-5565

20. PLEASE TELL ME WHETHER PROVIDING PUBLIC INFORMATION ON STORMWATER MANAGEMENT IS VERY IMPORTANT, IMPORTANT, OR NOT IMPORTANT IN PLANNING FUTURE COMMUNITY STORMWATER MANAGEMENT?

CORVALLIS
STORMWATER SURVEY
JANUARY, 1998

		---GENDER----		--------AGE---------			------EDUCATION-----			--RESIDENCE--		-----------AREA-----------				--RESIDENCY--	
	TOTAL	MALE	FEMALE	18-34	35-54	55PLUS	HIGH/ LESS	SOME COLLEG	COLLEG GRAD	OWN	RENT	NORTH EAST	NORTH WEST	SOUTH EAST	SOUTH WEST	<10YRS	10YRS>
TOTAL RESPONDENTS	366	184	182	100	158	102	62	105	195	230	129	34	217	27	75	176	188
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
VERY IMPORTANT	133	52	81	48	53	31	20	50	62	72	59	15	76	14	25	67	66
	36%	28%	45%	48%	34%	30%	32%	48%	32%	31%	46%	44%	35%	52%	33%	38%	35%
IMPORTANT	200	109	91	46	91	61	40	50	107	138	58	17	120	13	41	95	103
	55%	59%	50%	46%	58%	60%	65%	48%	55%	60%	45%	50%	55%	48%	55%	54%	55%
NOT IMPORTANT	29	21	8	6	13	9	1	4	24	17	11	1	20	0	8	14	15
	8%	11%	4%	6%	8%	9%	2%	4%	12%	7%	9%	3%	9%		11%	8%	8%
DON'T KNOW	4	2	2	0	1	1	1	1	2	3	1	1	1	0	1	0	4
	1%	1%	1%		1%	1%	2%	1%	1%	1%	1%	3%	*		1%		2%
TOTAL VERY IMPORTANT/IMPORTANT	333	161	172	94	144	92	60	100	169	210	117	32	196	27	66	162	169
	91%	88%	95%	94%	91%	90%	97%	95%	87%	91%	91%	94%	90%	100%	88%	92%	90%

MCARTHUR ASSOCIATES
(503) 228-5565

20. PLEASE TELL ME WHETHER PROVIDING PUBLIC INFORMATION ON STORMWATER MANAGEMENT IS VERY IMPORTANT, IMPORTANT, OR NOT IMPORTANT IN PLANNING FUTURE COMMUNITY STORMWATER MANAGEMENT?

		--UNRESOLVED-		-AFFEC FLOOD-		------STORMWATER BILL------			
	TOTAL	YES	NO/DK	YES	NO	HIGH	RIGHT	LOW	DK/NOP
TOTAL RESPONDENTS	366 100%	170 100%	196 100%	136 100%	230 100%	54 100%	120 100%	28 100%	164 100%
VERY IMPORTANT	133 36%	59 35%	74 38%	57 42%	76 33%	20 37%	36 30%	10 36%	67 41%
IMPORTANT	200 55%	95 56%	105 54%	68 50%	132 57%	28 52%	77 64%	15 54%	80 49%
NOT IMPORTANT	29 8%	15 9%	14 7%	9 7%	20 9%	6 11%	7 6%	3 11%	13 8%
DON'T KNOW	4 1%	1 1%	3 2%	2 1%	2 1%	0	0	0	4 2%
TOTAL VERY IMPORTANT/IMPORTANT	333 91%	154 91%	179 91%	125 92%	208 90%	48 89%	113 94%	25 89%	147 90%

MCARTHUR ASSOCIATES
(503) 228-5565

21. PLEASE TELL ME WHETHER ENCOURAGING PUBLIC ACCESS TO STREAMS IS VERY IMPORTANT, IMPORTANT, OR NOT IMPORTANT IN PLANNING FUTURE COMMUNITY STORMWATER MANAGEMENT?

CORVALLIS
STORMWATER SURVEY
JANUARY, 1998

		GENDER		AGE			EDUCATION			RESIDENCE		AREA				RESIDENCY	
	TOTAL	MALE	FEMALE	18-34	35-54	55PLUS	HIGH/ LESS	SOME COLLEG	COLLEG GRAD	OWN	RENT	NORTH EAST	NORTH WEST	SOUTH EAST	SOUTH WEST	<10YRS	10YRS>
TOTAL RESPONDENTS	366 100%	184 100%	182 100%	100 100%	158 100%	102 100%	62 100%	105 100%	195 100%	230 100%	129 100%	34 100%	217 100%	27 100%	75 100%	176 100%	188 100%
VERY IMPORTANT	63 17%	32 17%	31 17%	23 23%	28 18%	12 12%	12 19%	17 16%	32 16%	36 16%	26 20%	6 18%	33 15%	5 19%	18 24%	37 21%	26 14%
IMPORTANT	165 45%	80 43%	85 47%	45 45%	73 46%	45 44%	32 52%	56 53%	77 39%	101 44%	60 47%	21 62%	99 46%	11 41%	30 40%	82 47%	83 44%
NOT IMPORTANT	113 31%	64 35%	49 27%	29 29%	47 30%	35 34%	14 23%	24 23%	73 37%	73 32%	39 30%	7 21%	73 34%	11 41%	17 23%	49 28%	63 34%
DON'T KNOW	25 7%	8 4%	17 9%	3 3%	10 6%	10 10%	4 6%	8 8%	13 7%	20 9%	4 3%	0	12 6%	0	10 13%	8 5%	16 9%
TOTAL VERY IMPORTANT/IMPORTANT	228 62%	112 61%	116 64%	68 68%	101 64%	57 56%	44 71%	73 70%	109 56%	137 60%	86 67%	27 79%	132 61%	16 59%	48 64%	119 68%	109 58%

21. PLEASE TELL ME WHETHER ENCOURAGING PUBLIC ACCESS TO STREAMS IS VERY IMPORTANT, IMPORTANT, OR NOT IMPORTANT IN PLANNING FUTURE COMMUNITY STORMWATER MANAGEMENT?

		--UNRESOLVED-		-AFFEC FLOOD-		------STORMWATER BILL------			
	TOTAL	YES	NO/DK	YES	NO	HIGH	RIGHT	LOW	DK/NOP
TOTAL RESPONDENTS	366 100%	170 100%	196 100%	136 100%	230 100%	54 100%	120 100%	28 100%	164 100%
VERY IMPORTANT	63 17%	27 16%	36 18%	19 14%	44 19%	12 22%	20 17%	5 18%	26 16%
IMPORTANT	165 45%	74 44%	91 46%	67 49%	98 43%	24 44%	52 43%	13 46%	76 46%
NOT IMPORTANT	113 31%	58 34%	55 28%	39 29%	74 32%	13 24%	44 37%	8 29%	48 29%
DON'T KNOW	25 7%	11 6%	14 7%	11 8%	14 6%	5 9%	4 3%	2 7%	14 9%
TOTAL VERY IMPORTANT/IMPORTANT	228 62%	101 59%	127 65%	86 63%	142 62%	36 67%	72 60%	18 64%	102 62%

MCARTHUR ASSOCIATES
(503) 228-5565

22. PLEASE TELL ME WHETHER PROTECTING PUBLIC SAFETY IS VERY IMPORTANT, IMPORTANT, OR NOT IMPORTANT IN PLANNING FUTURE COMMUNITY STORMWATER MANAGEMENT?

CORVALLIS
STORMWATER SURVEY
JANUARY, 1998

		---GENDER----		--------AGE---------			------EDUCATION-----			--RESIDENCE--		-----------AREA-----------				--RESIDENCY--	
	TOTAL	MALE	FEMALE	18-34	35-54	55PLUS	HIGH/ LESS	SOME COLLEG	COLLEG GRAD	OWN	RENT	NORTH EAST	NORTH WEST	SOUTH EAST	SOUTH WEST	<10YRS	10YRS>
TOTAL RESPONDENTS	366 100%	184 100%	182 100%	100 100%	158 100%	102 100%	62 100%	105 100%	195 100%	230 100%	129 100%	34 100%	217 100%	27 100%	75 100%	176 100%	188 100%
VERY IMPORTANT	203 55%	95 52%	108 59%	65 65%	91 58%	45 44%	34 55%	64 61%	103 53%	128 56%	73 57%	24 71%	120 55%	19 70%	33 44%	102 58%	101 54%
IMPORTANT	146 40%	79 43%	67 37%	32 32%	64 41%	48 47%	25 40%	39 37%	81 42%	92 40%	50 39%	10 29%	89 41%	7 26%	36 48%	69 39%	76 40%
NOT IMPORTANT	11 3%	9 5%	2 1%	2 2%	1 1%	7 7%	2 3%	1 1%	7 4%	6 3%	4 3%	0	7 3%	0	3 4%	3 2%	7 4%
DON'T KNOW	6 2%	1 1%	5 3%	1 1%	2 1%	2 2%	1 2%	1 1%	4 2%	4 2%	2 2%	0	1 *	1 4%	3 4%	2 1%	4 2%
TOTAL VERY IMPORTANT/IMPORTANT	349 95%	174 95%	175 96%	97 97%	155 98%	93 91%	59 95%	103 98%	184 94%	220 96%	123 95%	34 100%	209 96%	26 96%	69 92%	171 97%	177 94%

MCARTHUR ASSOCIATES
(503) 228-5565

22. PLEASE TELL ME WHETHER PROTECTING PUBLIC SAFETY IS VERY IMPORTANT, IMPORTANT, OR NOT IMPORTANT IN PLANNING FUTURE COMMUNITY STORMWATER MANAGEMENT?

		--UNRESOLVED-		-AFFEC FLOOD-		------STORMWATER BILL------			
	TOTAL	YES	NO/DK	YES	NO	HIGH	RIGHT	LOW	DK/NOP
TOTAL RESPONDENTS	366 100%	170 100%	196 100%	136 100%	230 100%	54 100%	120 100%	28 100%	164 100%
VERY IMPORTANT	203 55%	93 55%	110 56%	88 65%	115 50%	33 61%	64 53%	16 57%	90 55%
IMPORTANT	146 40%	68 40%	78 40%	43 32%	103 45%	18 33%	51 43%	12 43%	65 40%
NOT IMPORTANT	11 3%	5 3%	6 3%	3 2%	8 3%	2 4%	5 4%	0	4 2%
DON'T KNOW	6 2%	4 2%	2 1%	2 1%	4 2%	1 2%	0	0	5 3%
TOTAL VERY IMPORTANT/IMPORTANT	349 95%	161 95%	188 96%	131 96%	218 95%	51 94%	115 96%	28 100%	155 95%

MCARTHUR ASSOCIATES
(503) 228-5565

23. PLEASE TELL ME WHETHER PREVENTING FLOOD DAMAGE TO HOMES AND BUSINESSES IS VERY IMPORTANT, IMPORTANT, OR NOT IMPORTANT IN PLANNING FUTURE COMMUNITY STORMWATER MANAGEMENT?

CORVALLIS
STORMWATER SURVEY
JANUARY, 1998

		GENDER		AGE			EDUCATION			RESIDENCE		AREA				RESIDENCY	
	TOTAL	MALE	FEMALE	18-34	35-54	55PLUS	HIGH/ LESS	SOME COLLEG	COLLEG GRAD	OWN	RENT	NORTH EAST	NORTH WEST	SOUTH EAST	SOUTH WEST	<10YRS	10YRS>
TOTAL RESPONDENTS	366	184	182	100	158	102	62	105	195	230	129	34	217	27	75	176	188
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
VERY IMPORTANT	218	94	124	56	92	67	42	65	109	135	79	24	139	12	37	107	111
	60%	51%	68%	56%	58%	66%	68%	62%	56%	59%	61%	71%	64%	44%	49%	61%	59%
IMPORTANT	130	78	52	41	58	30	16	35	77	82	45	8	69	14	34	63	65
	36%	42%	29%	41%	37%	29%	26%	33%	39%	36%	35%	24%	32%	52%	45%	36%	35%
NOT IMPORTANT	13	10	3	3	6	4	3	4	6	8	5	1	9	1	2	5	8
	4%	5%	2%	3%	4%	4%	5%	4%	3%	3%	4%	3%	4%	4%	3%	3%	4%
DON'T KNOW	5	2	3	0	2	1	1	1	3	5	0	1	0	0	2	1	4
	1%	1%	2%		1%	1%	2%	1%	2%	2%		3%			3%	1%	2%
TOTAL VERY IMPORTANT/IMPORTANT	348	172	176	97	150	97	58	100	186	217	124	32	208	26	71	170	176
	95%	93%	97%	97%	95%	95%	94%	95%	95%	94%	96%	94%	96%	96%	95%	97%	94%

MCARTHUR ASSOCIATES
(503) 228-5565

23. PLEASE TELL ME WHETHER PREVENTING FLOOD DAMAGE TO HOMES AND BUSINESSES IS VERY IMPORTANT, IMPORTANT, OR NOT IMPORTANT IN PLANNING FUTURE COMMUNITY STORMWATER MANAGEMENT?

		--UNRESOLVED-		-AFFEC FLOOD-		------STORMWATER BILL------			
	TOTAL	YES	NO/DK	YES	NO	HIGH	RIGHT	LOW	DK/NOP
TOTAL RESPONDENTS	366 100%	170 100%	196 100%	136 100%	230 100%	54 100%	120 100%	28 100%	164 100%
VERY IMPORTANT	218 60%	101 59%	117 60%	96 71%	122 53%	34 63%	68 57%	17 61%	99 60%
IMPORTANT	130 36%	62 36%	68 35%	36 26%	94 41%	17 31%	47 39%	10 36%	56 34%
NOT IMPORTANT	13 4%	6 4%	7 4%	1 1%	12 5%	2 4%	4 3%	1 4%	6 4%
DON'T KNOW	5 1%	1 1%	4 2%	3 2%	2 1%	1 2%	1 1%	0	3 2%
TOTAL VERY IMPORTANT/IMPORTANT	348 95%	163 96%	185 94%	132 97%	216 94%	51 94%	115 96%	27 96%	155 95%

24. PLEASE TELL ME WHETHER PROTECTING STREAM HABITAT IS VERY IMPORTANT, IMPORTANT, OR NOT IMPORTANT IN PLANNING FUTURE COMMUNITY STORMWATER MANAGEMENT?

CORVALLIS
STORMWATER SURVEY
JANUARY, 1998

		---GENDER---		---AGE---			---EDUCATION---			--RESIDENCE--		---AREA---				--RESIDENCY--	
	TOTAL	MALE	FEMALE	18-34	35-54	55PLUS	HIGH/ LESS	SOME COLLEG	COLLEG GRAD	OWN	RENT	NORTH EAST	NORTH WEST	SOUTH EAST	SOUTH WEST	<10YRS	10YRS>
TOTAL RESPONDENTS	366 100%	184 100%	182 100%	100 100%	158 100%	102 100%	62 100%	105 100%	195 100%	230 100%	129 100%	34 100%	217 100%	27 100%	75 100%	176 100%	188 100%
VERY IMPORTANT	220 60%	100 54%	120 66%	75 75%	97 61%	44 43%	35 56%	69 66%	113 58%	129 56%	86 67%	24 71%	121 56%	19 70%	48 64%	114 65%	105 56%
IMPORTANT	125 34%	67 36%	58 32%	24 24%	55 35%	45 44%	21 34%	34 32%	69 35%	86 37%	38 29%	7 21%	84 39%	7 26%	24 32%	56 32%	68 36%
NOT IMPORTANT	18 5%	17 9%	1 1%	1 1%	6 4%	11 11%	4 6%	2 2%	12 6%	13 6%	4 3%	2 6%	12 6%	1 4%	2 3%	5 3%	13 7%
DON'T KNOW	3 1%	0	3 2%	0	0	2 2%	2 3%	0	1 1%	2 1%	1 1%	1 3%	0	0	1 1%	1 1%	2 1%
TOTAL VERY IMPORTANT/IMPORTANT	345 94%	167 91%	178 98%	99 99%	152 96%	89 87%	56 90%	103 98%	182 93%	215 93%	124 96%	31 91%	205 94%	26 96%	72 96%	170 97%	173 92%

MCARTHUR ASSOCIATES
(503) 228-5565

24. PLEASE TELL ME WHETHER PROTECTING STREAM HABITAT IS VERY IMPORTANT, IMPORTANT, OR NOT IMPORTANT IN PLANNING FUTURE COMMUNITY STORMWATER MANAGEMENT?

		--UNRESOLVED-		-AFFEC FLOOD-		------STORMWATER BILL------			
	TOTAL	YES	NO/DK	YES	NO	HIGH	RIGHT	LOW	DK/NOP
TOTAL RESPONDENTS	366 100%	170 100%	196 100%	136 100%	230 100%	54 100%	120 100%	28 100%	164 100%
VERY IMPORTANT	220 60%	105 62%	115 59%	92 68%	128 56%	21 39%	80 67%	14 50%	105 64%
IMPORTANT	125 34%	55 32%	70 36%	38 28%	87 38%	26 48%	34 28%	11 39%	54 33%
NOT IMPORTANT	18 5%	9 5%	9 5%	5 4%	13 6%	6 11%	6 5%	3 11%	3 2%
DON'T KNOW	3 1%	1 1%	2 1%	1 1%	2 1%	1 2%	0	0	2 1%
TOTAL VERY IMPORTANT/IMPORTANT	345 94%	160 94%	185 94%	130 96%	215 93%	47 87%	114 95%	25 89%	159 97%

MCARTHUR ASSOCIATES
(503) 228-5565

25. PLEASE TELL ME WHETHER CONTROLLING EROSION IS VERY IMPORTANT, IMPORTANT, OR NOT IMPORTANT IN PLANNING FUTURE COMMUNITY STORMWATER MANAGEMENT?

CORVALLIS
STORMWATER SURVEY
JANUARY, 1998

		GENDER		AGE			EDUCATION			RESIDENCE		AREA				RESIDENCY	
	TOTAL	MALE	FEMALE	18-34	35-54	55PLUS	HIGH/ LESS	SOME COLLEG	COLLEG GRAD	OWN	RENT	NORTH EAST	NORTH WEST	SOUTH EAST	SOUTH WEST	<10YRS	10YRS>
TOTAL RESPONDENTS	366 100%	184 100%	182 100%	100 100%	158 100%	102 100%	62 100%	105 100%	195 100%	230 100%	129 100%	34 100%	217 100%	27 100%	75 100%	176 100%	188 100%
VERY IMPORTANT	196 54%	86 47%	110 60%	58 58%	86 54%	47 46%	32 52%	58 55%	103 53%	118 51%	73 57%	22 65%	109 50%	17 63%	40 53%	102 58%	93 49%
IMPORTANT	154 42%	86 47%	68 37%	39 39%	66 42%	49 48%	27 44%	42 40%	84 43%	100 43%	52 40%	11 32%	101 47%	9 33%	31 41%	68 39%	86 46%
NOT IMPORTANT	12 3%	11 6%	1 1%	2 2%	6 4%	4 4%	3 5%	2 2%	7 4%	9 4%	3 2%	1 3%	7 3%	1 4%	2 3%	6 3%	6 3%
DON'T KNOW	4 1%	1 1%	3 2%	1 1%	0	2 2%	0	3 3%	1 1%	3 1%	1 1%	0	0	0	2 3%	0	3 2%
TOTAL VERY IMPORTANT/IMPORTANT	350 96%	172 93%	178 98%	97 97%	152 96%	96 94%	59 95%	100 95%	187 96%	218 95%	125 97%	33 97%	210 97%	26 96%	71 95%	170 97%	179 95%

MCARTHUR ASSOCIATES
(503) 228-5565

25. PLEASE TELL ME WHETHER CONTROLLING EROSION IS VERY IMPORTANT, IMPORTANT, OR NOT IMPORTANT IN PLANNING FUTURE COMMUNITY STORMWATER MANAGEMENT?

		--UNRESOLVED-		-AFFEC FLOOD-		------STORMWATER BILL------			
	TOTAL	YES	NO/DK	YES	NO	HIGH	RIGHT	LOW	DK/NOP
TOTAL RESPONDENTS	366 100%	170 100%	196 100%	136 100%	230 100%	54 100%	120 100%	28 100%	164 100%
VERY IMPORTANT	196 54%	95 56%	101 52%	80 59%	116 50%	20 37%	71 59%	12 43%	93 57%
IMPORTANT	154 42%	70 41%	84 43%	50 37%	104 45%	31 57%	45 38%	14 50%	64 39%
NOT IMPORTANT	12 3%	3 2%	9 5%	3 2%	9 4%	3 6%	3 3%	2 7%	4 2%
DON'T KNOW	4 1%	2 1%	2 1%	3 2%	1 *	0	1 1%	0	3 2%
TOTAL VERY IMPORTANT/IMPORTANT	350 96%	165 97%	185 94%	130 96%	220 96%	51 94%	116 97%	26 93%	157 96%

MCARTHUR ASSOCIATES
(503) 228-5565

26. PLEASE TELL ME WHETHER CONTROLLING DEVELOPMENT IS VERY IMPORTANT, IMPORTANT, OR NOT IMPORTANT IN PLANNING FUTURE COMMUNITY STORMWATER MANAGEMENT?

CORVALLIS
STORMWATER SURVEY
JANUARY, 1998

		---GENDER----		--------AGE---------			------EDUCATION-----			--RESIDENCE--		-----------AREA-----------				--RESIDENCY--	
	TOTAL	MALE	FEMALE	18-34	35-54	55PLUS	HIGH/ LESS	SOME COLLEG	COLLEG GRAD	OWN	RENT	NORTH EAST	NORTH WEST	SOUTH EAST	SOUTH WEST	<10YRS	10YRS>
TOTAL RESPONDENTS	366 100%	184 100%	182 100%	100 100%	158 100%	102 100%	62 100%	105 100%	195 100%	230 100%	129 100%	34 100%	217 100%	27 100%	75 100%	176 100%	188 100%
VERY IMPORTANT	198 54%	91 49%	107 59%	58 58%	90 57%	45 44%	27 44%	62 59%	105 54%	122 53%	71 55%	24 71%	109 50%	17 63%	42 56%	92 52%	105 56%
IMPORTANT	129 35%	68 37%	61 34%	32 32%	51 32%	46 45%	30 48%	35 33%	64 33%	89 39%	38 29%	10 29%	82 38%	9 33%	24 32%	62 35%	67 36%
NOT IMPORTANT	30 8%	21 11%	9 5%	9 9%	16 10%	5 5%	5 8%	6 6%	19 10%	13 6%	17 13%	0	22 10%	1 4%	7 9%	20 11%	10 5%
DON'T KNOW	9 2%	4 2%	5 3%	1 1%	1 1%	6 6%	0	2 2%	7 4%	6 3%	3 2%	0	4 2%	0	2 3%	2 1%	6 3%
TOTAL VERY IMPORTANT/IMPORTANT	327 89%	159 86%	168 92%	90 90%	141 89%	91 89%	57 92%	97 92%	169 87%	211 92%	109 84%	34 100%	191 88%	26 96%	66 88%	154 88%	172 91%

MCARTHUR ASSOCIATES
(503) 228-5565

26. PLEASE TELL ME WHETHER CONTROLLING DEVELOPMENT IS VERY IMPORTANT, IMPORTANT, OR NOT IMPORTANT IN PLANNING FUTURE COMMUNITY STORMWATER MANAGEMENT?

		--UNRESOLVED-		-AFFEC FLOOD-		------STORMWATER BILL------			
	TOTAL	YES	NO/DK	YES	NO	HIGH	RIGHT	LOW	DK/NOP
TOTAL RESPONDENTS	366 100%	170 100%	196 100%	136 100%	230 100%	54 100%	120 100%	28 100%	164 100%
VERY IMPORTANT	198 54%	103 61%	95 48%	91 67%	107 47%	23 43%	75 63%	19 68%	81 49%
IMPORTANT	129 35%	53 31%	76 39%	36 26%	93 40%	25 46%	32 27%	7 25%	65 40%
NOT IMPORTANT	30 8%	11 6%	19 10%	7 5%	23 10%	6 11%	10 8%	2 7%	12 7%
DON'T KNOW	9 2%	3 2%	6 3%	2 1%	7 3%	0	3 3%	0	6 4%
TOTAL VERY IMPORTANT/IMPORTANT	327 89%	156 92%	171 87%	127 93%	200 87%	48 89%	107 89%	26 93%	146 89%

MCARTHUR ASSOCIATES
(503) 228-5565

27. PLEASE TELL ME WHETHER RETAINING STORMWATER ON-SITE FOR NEW DEVELOPMENT IS VERY IMPORTANT, IMPORTANT, OR NOT IMPORTANT IN PLANNING FUTURE COMMUNITY STORMWATER MANAGEMENT?

CORVALLIS
STORMWATER SURVEY
JANUARY, 1998

		---GENDER----		--------AGE---------			------EDUCATION-----			--RESIDENCE--		-----------AREA-----------				--RESIDENCY--	
	TOTAL	MALE	FEMALE	18-34	35-54	55PLUS	HIGH/ LESS	SOME COLLEG	COLLEG GRAD	OWN	RENT	NORTH EAST	NORTH WEST	SOUTH EAST	SOUTH WEST	<10YRS	10YRS>
TOTAL RESPONDENTS	366	184	182	100	158	102	62	105	195	230	129	34	217	27	75	176	188
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
VERY IMPORTANT	68	39	29	25	24	19	14	21	32	42	24	5	41	2	15	36	32
	19%	21%	16%	25%	15%	19%	23%	20%	16%	18%	19%	15%	19%	7%	20%	20%	17%
IMPORTANT	147	71	76	44	66	34	33	43	69	87	57	17	86	10	30	78	68
	40%	39%	42%	44%	42%	33%	53%	41%	35%	38%	44%	50%	40%	37%	40%	44%	36%
NOT IMPORTANT	43	29	14	16	18	9	3	10	30	22	19	1	30	3	8	24	19
	12%	16%	8%	16%	11%	9%	5%	10%	15%	10%	15%	3%	14%	11%	11%	14%	10%
DON'T KNOW	108	45	63	15	50	40	12	31	64	79	29	11	60	12	22	38	69
	30%	24%	35%	15%	32%	39%	19%	30%	33%	34%	22%	32%	28%	44%	29%	22%	37%
TOTAL VERY IMPORTANT/IMPORTANT	215	110	105	69	90	53	47	64	101	129	81	22	127	12	45	114	100
	59%	60%	58%	69%	57%	52%	76%	61%	52%	56%	63%	65%	59%	44%	60%	65%	53%

MCARTHUR ASSOCIATES
(503) 228-5565

27. PLEASE TELL ME WHETHER RETAINING STORMWATER ON-SITE FOR NEW DEVELOPMENT IS VERY IMPORTANT, IMPORTANT, OR NOT IMPORTANT IN PLANNING FUTURE COMMUNITY STORMWATER MANAGEMENT?

		--UNRESOLVED-		-AFFEC FLOOD-		------STORMWATER BILL------			
	TOTAL	YES	NO/DK	YES	NO	HIGH	RIGHT	LOW	DK/NOP
TOTAL RESPONDENTS	366 100%	170 100%	196 100%	136 100%	230 100%	54 100%	120 100%	28 100%	164 100%
VERY IMPORTANT	68 19%	33 19%	35 18%	24 18%	44 19%	8 15%	27 23%	3 11%	30 18%
IMPORTANT	147 40%	66 39%	81 41%	54 40%	93 40%	21 39%	49 41%	17 61%	60 37%
NOT IMPORTANT	43 12%	24 14%	19 10%	15 11%	28 12%	9 17%	10 8%	4 14%	20 12%
DON'T KNOW	108 30%	47 28%	61 31%	43 32%	65 28%	16 30%	34 28%	4 14%	54 33%
TOTAL VERY IMPORTANT/IMPORTANT	215 59%	99 58%	116 59%	78 57%	137 60%	29 54%	76 63%	20 71%	90 55%

MCARTHUR ASSOCIATES
(503) 228-5565

28. PLEASE TELL ME WHETHER REDUCING CITY MAINTENANCE COSTS IS VERY IMPORTANT, IMPORTANT, OR NOT IMPORTANT IN PLANNING FUTURE COMMUNITY STORMWATER MANAGEMENT?

CORVALLIS
STORMWATER SURVEY
JANUARY, 1998

		GENDER		AGE			EDUCATION			RESIDENCE		AREA				RESIDENCY	
	TOTAL	MALE	FEMALE	18-34	35-54	55PLUS	HIGH/ LESS	SOME COLLEG	COLLEG GRAD	OWN	RENT	NORTH EAST	NORTH WEST	SOUTH EAST	SOUTH WEST	<10YRS	10YRS>
TOTAL RESPONDENTS	366	184	182	100	158	102	62	105	195	230	129	34	217	27	75	176	188
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
VERY IMPORTANT	61	36	25	25	21	13	13	25	22	27	29	12	29	4	14	35	26
	17%	20%	14%	25%	13%	13%	21%	24%	11%	12%	22%	35%	13%	15%	19%	20%	14%
IMPORTANT	200	102	98	53	89	57	31	60	108	137	62	12	131	14	38	93	107
	55%	55%	54%	53%	56%	56%	50%	57%	55%	60%	48%	35%	60%	52%	51%	53%	57%
NOT IMPORTANT	83	43	40	20	43	18	13	14	54	51	31	8	45	9	18	38	44
	23%	23%	22%	20%	27%	18%	21%	13%	28%	22%	24%	24%	21%	33%	24%	22%	23%
DON'T KNOW	22	3	19	2	5	14	5	6	11	15	7	2	12	0	5	10	11
	6%	2%	10%	2%	3%	14%	8%	6%	6%	7%	5%	6%	6%		7%	6%	6%
TOTAL VERY IMPORTANT/IMPORTANT	261	138	123	78	110	70	44	85	130	164	91	24	160	18	52	128	133
	71%	75%	68%	78%	70%	69%	71%	81%	67%	71%	71%	71%	74%	67%	69%	73%	71%

MCARTHUR ASSOCIATES
(503) 228-5565

28. PLEASE TELL ME WHETHER REDUCING CITY MAINTENANCE COSTS IS VERY IMPORTANT, IMPORTANT, OR NOT IMPORTANT IN PLANNING FUTURE COMMUNITY STORMWATER MANAGEMENT?

		--UNRESOLVED-		-AFFEC FLOOD-		------STORMWATER BILL------			
	TOTAL	YES	NO/DK	YES	NO	HIGH	RIGHT	LOW	DK/NOP
TOTAL RESPONDENTS	366 100%	170 100%	196 100%	136 100%	230 100%	54 100%	120 100%	28 100%	164 100%
VERY IMPORTANT	61 17%	22 13%	39 20%	23 17%	38 17%	9 17%	16 13%	3 11%	33 20%
IMPORTANT	200 55%	91 54%	109 56%	70 51%	130 57%	35 65%	69 58%	16 57%	80 49%
NOT IMPORTANT	83 23%	48 28%	35 18%	35 26%	48 21%	7 13%	32 27%	9 32%	35 21%
DON'T KNOW	22 6%	9 5%	13 7%	8 6%	14 6%	3 6%	3 3%	0	16 10%
TOTAL VERY IMPORTANT/IMPORTANT	261 71%	113 66%	148 76%	93 68%	168 73%	44 81%	85 71%	19 68%	113 69%

MCARTHUR ASSOCIATES
(503) 228-5565

29. PLEASE TELL ME WHETHER MINIMIZING UTILITY RATES IS VERY IMPORTANT, IMPORTANT, OR NOT IMPORTANT IN PLANNING FUTURE COMMUNITY STORMWATER MANAGEMENT?

CORVALLIS
STORMWATER SURVEY
JANUARY, 1998

		GENDER		AGE			EDUCATION			RESIDENCE		AREA				RESIDENCY	
	TOTAL	MALE	FEMALE	18-34	35-54	55PLUS	HIGH/ LESS	SOME COLLEG	COLLEG GRAD	OWN	RENT	NORTH EAST	NORTH WEST	SOUTH EAST	SOUTH WEST	<10YRS	10YRS>
TOTAL RESPONDENTS	366 100%	184 100%	182 100%	100 100%	158 100%	102 100%	62 100%	105 100%	195 100%	230 100%	129 100%	34 100%	217 100%	27 100%	75 100%	176 100%	188 100%
VERY IMPORTANT	84 23%	48 26%	36 20%	28 28%	36 23%	18 18%	25 40%	30 29%	28 14%	41 18%	40 31%	14 41%	49 23%	2 7%	14 19%	43 24%	41 22%
IMPORTANT	185 51%	87 47%	98 54%	53 53%	80 51%	51 50%	32 52%	54 51%	98 50%	120 52%	62 48%	12 35%	108 50%	20 74%	41 55%	86 49%	99 53%
NOT IMPORTANT	80 22%	43 23%	37 20%	17 17%	38 24%	24 24%	4 6%	15 14%	59 30%	56 24%	23 18%	5 15%	52 24%	5 19%	16 21%	41 23%	38 20%
DON'T KNOW	17 5%	6 3%	11 6%	2 2%	4 3%	9 9%	1 2%	6 6%	10 5%	13 6%	4 3%	3 9%	8 4%	0	4 5%	6 3%	10 5%
TOTAL VERY IMPORTANT/IMPORTANT	269 73%	135 73%	134 74%	81 81%	116 73%	69 68%	57 92%	84 80%	126 65%	161 70%	102 79%	26 76%	157 72%	22 81%	55 73%	129 73%	140 74%

MCARTHUR ASSOCIATES
(503) 228-5565

29. PLEASE TELL ME WHETHER MINIMIZING UTILITY RATES IS VERY IMPORTANT, IMPORTANT, OR NOT IMPORTANT IN PLANNING FUTURE COMMUNITY STORMWATER MANAGEMENT?

		--UNRESOLVED-		-AFFEC FLOOD-		------STORMWATER BILL------			
	TOTAL	YES	NO/DK	YES	NO	HIGH	RIGHT	LOW	DK/NOP
TOTAL RESPONDENTS	366 100%	170 100%	196 100%	136 100%	230 100%	54 100%	120 100%	28 100%	164 100%
VERY IMPORTANT	84 23%	38 22%	46 23%	33 24%	51 22%	14 26%	24 20%	4 14%	42 26%
IMPORTANT	185 51%	78 46%	107 55%	68 50%	117 51%	35 65%	61 51%	12 43%	77 47%
NOT IMPORTANT	80 22%	43 25%	37 19%	30 22%	50 22%	3 6%	33 28%	12 43%	32 20%
DON'T KNOW	17 5%	11 6%	6 3%	5 4%	12 5%	2 4%	2 2%	0	13 8%
TOTAL VERY IMPORTANT/IMPORTANT	269 73%	116 68%	153 78%	101 74%	168 73%	49 91%	85 71%	16 57%	119 73%

MCARTHUR ASSOCIATES
(503) 228-5565

30. PLEASE TELL ME WHETHER PROTECTING WETLANDS IS VERY IMPORTANT, IMPORTANT, OR NOT IMPORTANT IN PLANNING FUTURE COMMUNITY STORMWATER MANAGEMENT?

CORVALLIS
STORMWATER SURVEY
JANUARY, 1998

		GENDER		AGE			EDUCATION			RESIDENCE		AREA				RESIDENCY	
	TOTAL	MALE	FEMALE	18-34	35-54	55PLUS	HIGH/ LESS	SOME COLLEG	COLLEG GRAD	OWN	RENT	NORTH EAST	NORTH WEST	SOUTH EAST	SOUTH WEST	<10YRS	10YRS>
TOTAL RESPONDENTS	366	184	182	100	158	102	62	105	195	230	129	34	217	27	75	176	188
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
VERY IMPORTANT	204	98	106	68	92	39	29	62	110	120	79	26	114	15	42	108	95
	56%	53%	58%	68%	58%	38%	47%	59%	56%	52%	61%	76%	53%	56%	56%	61%	51%
IMPORTANT	119	58	61	27	50	42	25	31	63	81	37	5	79	9	24	53	66
	33%	32%	34%	27%	32%	41%	40%	30%	32%	35%	29%	15%	36%	33%	32%	30%	35%
NOT IMPORTANT	32	21	11	5	13	14	5	9	17	19	13	2	22	2	5	14	18
	9%	11%	6%	5%	8%	14%	8%	9%	9%	8%	10%	6%	10%	7%	7%	8%	10%
DON'T KNOW	11	7	4	0	3	7	3	3	5	10	0	1	2	1	4	1	9
	3%	4%	2%		2%	7%	5%	3%	3%	4%		3%	1%	4%	5%	1%	5%
TOTAL VERY IMPORTANT/IMPORTANT	323	156	167	95	142	81	54	93	173	201	116	31	193	24	66	161	161
	88%	85%	92%	95%	90%	79%	87%	89%	89%	87%	90%	91%	89%	89%	88%	91%	86%

MCARTHUR ASSOCIATES
(503) 228-5565

30. PLEASE TELL ME WHETHER PROTECTING WETLANDS IS VERY IMPORTANT, IMPORTANT, OR NOT IMPORTANT IN PLANNING FUTURE COMMUNITY STORMWATER MANAGEMENT?

		--UNRESOLVED-		-AFFEC FLOOD-		------STORMWATER BILL------			
	TOTAL	YES	NO/DK	YES	NO	HIGH	RIGHT	LOW	DK/NOP
TOTAL RESPONDENTS	366	170	196	136	230	54	120	28	164
	100%	100%	100%	100%	100%	100%	100%	100%	100%
VERY IMPORTANT	204	103	101	83	121	24	65	19	96
	56%	61%	52%	61%	53%	44%	54%	68%	59%
IMPORTANT	119	52	67	41	78	22	42	6	49
	33%	31%	34%	30%	34%	41%	35%	21%	30%
NOT IMPORTANT	32	11	21	8	24	5	11	2	14
	9%	6%	11%	6%	10%	9%	9%	7%	9%
DON'T KNOW	11	4	7	4	7	3	2	1	5
	3%	2%	4%	3%	3%	6%	2%	4%	3%
TOTAL VERY IMPORTANT/IMPORTANT	323	155	168	124	199	46	107	25	145
	88%	91%	86%	91%	87%	85%	89%	89%	88%

MCARTHUR ASSOCIATES
(503) 228-5565

31. PLEASE TELL ME WHETHER MEETING STATE-WIDE REGULATIONS IS VERY IMPORTANT, IMPORTANT, OR NOT IMPORTANT IN PLANNING FUTURE COMMUNITY STORMWATER MANAGEMENT?

CORVALLIS
STORMWATER SURVEY
JANUARY, 1998

		---GENDER----		--------AGE---------			------EDUCATION-----			--RESIDENCE--		-----------AREA-----------				--RESIDENCY--	
	TOTAL	MALE	FEMALE	18-34	35-54	55PLUS	HIGH/ LESS	SOME COLLEG	COLLEG GRAD	OWN	RENT	NORTH EAST	NORTH WEST	SOUTH EAST	SOUTH WEST	<10YRS	10YRS>
TOTAL RESPONDENTS	366 100%	184 100%	182 100%	100 100%	158 100%	102 100%	62 100%	105 100%	195 100%	230 100%	129 100%	34 100%	217 100%	27 100%	75 100%	176 100%	188 100%
VERY IMPORTANT	148 40%	62 34%	86 47%	49 49%	68 43%	30 29%	18 29%	51 49%	77 39%	92 40%	54 42%	14 41%	90 41%	13 48%	28 37%	73 41%	75 40%
IMPORTANT	185 51%	99 54%	86 47%	49 49%	74 47%	59 58%	39 63%	45 43%	100 51%	112 49%	69 53%	18 53%	112 52%	13 48%	37 49%	90 51%	95 51%
NOT IMPORTANT	19 5%	16 9%	3 2%	1 1%	10 6%	7 7%	3 5%	5 5%	10 5%	15 7%	3 2%	2 6%	10 5%	0	5 7%	7 4%	11 6%
DON'T KNOW	14 4%	7 4%	7 4%	1 1%	6 4%	6 6%	2 3%	4 4%	8 4%	11 5%	3 2%	0	5 2%	1 4%	5 7%	6 3%	7 4%
TOTAL VERY IMPORTANT/IMPORTANT	333 91%	161 88%	172 95%	98 98%	142 90%	89 87%	57 92%	96 91%	177 91%	204 89%	123 95%	32 94%	202 93%	26 96%	65 87%	163 93%	170 90%

MCARTHUR ASSOCIATES
(503) 228-5565

31. PLEASE TELL ME WHETHER MEETING STATE-WIDE REGULATIONS IS VERY IMPORTANT, IMPORTANT, OR NOT IMPORTANT IN PLANNING FUTURE COMMUNITY STORMWATER MANAGEMENT?

		--UNRESOLVED-		-AFFEC FLOOD-		------STORMWATER BILL------			
	TOTAL	YES	NO/DK	YES	NO	HIGH	RIGHT	LOW	DK/NOP
TOTAL RESPONDENTS	366 100%	170 100%	196 100%	136 100%	230 100%	54 100%	120 100%	28 100%	164 100%
VERY IMPORTANT	148 40%	75 44%	73 37%	62 46%	86 37%	18 33%	49 41%	13 46%	68 41%
IMPORTANT	185 51%	79 46%	106 54%	62 46%	123 53%	29 54%	60 50%	13 46%	83 51%
NOT IMPORTANT	19 5%	8 5%	11 6%	6 4%	13 6%	7 13%	6 5%	2 7%	4 2%
DON'T KNOW	14 4%	8 5%	6 3%	6 4%	8 3%	0	5 4%	0	9 5%
TOTAL VERY IMPORTANT/IMPORTANT	333 91%	154 91%	179 91%	124 91%	209 91%	47 87%	109 91%	26 93%	151 92%

MCARTHUR ASSOCIATES
(503) 228-5565

32. WHO SHOULD BE PRIMARILY RESPONSIBLE FOR TAKING ACTIONS IN OUR COMMUNITY TO ENHANCE URBAN STREAMS OR BETTER MANAGE STORMWATER DRAINAGE PROBLEMS IN THE FUTURE? (MULTIPLE RESPONSE)

CORVALLIS
STORMWATER SURVEY
JANUARY, 1998

		GENDER		AGE			EDUCATION			RESIDENCE		AREA				RESIDENCY	
	TOTAL	MALE	FEMALE	18-34	35-54	55PLUS	HIGH/ LESS	SOME COLLEG	COLLEG GRAD	OWN	RENT	NORTH EAST	NORTH WEST	SOUTH EAST	SOUTH WEST	<10YRS	10YRS>
TOTAL RESPONDENTS	366	184	182	100	158	102	62	105	195	230	129	34	217	27	75	176	188
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
CITY OF CORVALLIS	264	141	123	76	114	72	37	71	153	175	85	25	159	21	50	126	138
	72%	77%	68%	76%	72%	71%	60%	68%	78%	76%	66%	74%	73%	78%	67%	72%	73%
PRIVATE CITIZENS	109	52	57	36	48	24	22	39	46	61	45	10	62	11	24	54	54
	30%	28%	31%	36%	30%	24%	35%	37%	24%	27%	35%	29%	29%	41%	32%	31%	29%
DEVELOPERS	52	24	28	12	26	14	7	13	32	37	15	4	34	2	11	32	20
	14%	13%	15%	12%	16%	14%	11%	12%	16%	16%	12%	12%	16%	7%	15%	18%	11%
THE STATE/GOVERNMENT/AGENCY	34	23	11	13	12	9	4	6	23	17	17	3	18	4	8	20	14
	9%	13%	6%	13%	8%	9%	6%	6%	12%	7%	13%	9%	8%	15%	11%	11%	7%
COUNTY/GOVERNMENT/AGENCY	28	18	10	3	14	11	5	5	16	21	7	1	17	2	7	10	18
	8%	10%	5%	3%	9%	11%	8%	5%	8%	9%	5%	3%	8%	7%	9%	6%	10%
LOCAL COMMUNITY/COMMITTEE	22	11	11	12	6	4	1	8	12	11	11	0	13	2	6	13	9
	6%	6%	6%	12%	4%	4%	2%	8%	6%	5%	9%		6%	7%	8%	7%	5%
WATER SYSTEMS EXPERTS	12	4	8	2	5	4	0	1	10	7	4	0	5	0	6	6	6
	3%	2%	4%	2%	3%	4%		1%	5%	3%	3%		2%		8%	3%	3%
EVERYBODY	11	4	7	4	5	2	4	5	2	6	5	2	3	0	6	6	5
	3%	2%	4%	4%	3%	2%	6%	5%	1%	3%	4%	6%	1%		8%	3%	3%
BUSINESS/OWNERS	6	3	3	4	1	1	2	3	1	2	3	1	3	0	2	3	3
	2%	2%	2%	4%	1%	1%	3%	3%	1%	1%	2%	3%	1%		3%	2%	2%
ENVIRONMENTAL ACTIVISTS/ EXPERTS/GROUPS	6	3	3	1	5	0	0	2	4	3	2	0	3	0	3	4	2
	2%	2%	2%	1%	3%			2%	2%	1%	2%		1%		4%	2%	1%
OTHER	1	1	0	0	1	0	0	0	1	1	0	0	1	0	0	0	1
	*	1%			1%				1%	*			*				1%

MCARTHUR ASSOCIATES
(503) 228-5565

32. WHO SHOULD BE PRIMARILY RESPONSIBLE FOR TAKING ACTIONS IN OUR COMMUNITY TO ENHANCE URBAN STREAMS OR BETTER MANAGE STORMWATER DRAINAGE PROBLEMS IN THE FUTURE? (MULTIPLE RESPONSE)

		--UNRESOLVED-		-AFFEC FLOOD-		------STORMWATER BILL------			
	TOTAL	YES	NO/DK	YES	NO	HIGH	RIGHT	LOW	DK/NOP
TOTAL RESPONDENTS	366 100%	170 100%	196 100%	136 100%	230 100%	54 100%	120 100%	28 100%	164 100%
CITY OF CORVALLIS	264 72%	130 76%	134 68%	99 73%	165 72%	35 65%	91 76%	22 79%	116 71%
PRIVATE CITIZENS	109 30%	43 25%	66 34%	45 33%	64 28%	14 26%	34 28%	11 39%	50 30%
DEVELOPERS	52 14%	26 15%	26 13%	12 9%	40 17%	4 7%	20 17%	2 7%	26 16%
THE STATE/GOVERNMENT/AGENCY	34 9%	14 8%	20 10%	14 10%	20 9%	4 7%	10 8%	2 7%	18 11%
COUNTY/GOVERNMENT/AGENCY	28 8%	16 9%	12 6%	11 8%	17 7%	3 6%	10 8%	2 7%	13 8%
LOCAL COMMUNITY/COMMITTEE	22 6%	8 5%	14 7%	12 9%	10 4%	6 11%	3 3%	2 7%	11 7%
WATER SYSTEMS EXPERTS	12 3%	4 2%	8 4%	3 2%	9 4%	2 4%	3 3%	1 4%	6 4%
EVERYBODY	11 3%	5 3%	6 3%	4 3%	7 3%	2 4%	1 1%	1 4%	7 4%
BUSINESS/OWNERS	6 2%	2 1%	4 2%	3 2%	3 1%	0	1 1%	0	5 3%
ENVIRONMENTAL ACTIVISTS/ EXPERTS/GROUPS	6 2%	3 2%	3 2%	3 2%	3 1%	0	2 2%	0	4 2%
OTHER	1 *	1 1%	0	1 1%	0	1 2%	0	0	0

MCARTHUR ASSOCIATES
(503) 228-5565

32. WHO SHOULD BE PRIMARILY RESPONSIBLE FOR TAKING ACTIONS IN OUR COMMUNITY TO ENHANCE URBAN STREAMS OR BETTER MANAGE STORMWATER DRAINAGE PROBLEMS IN THE FUTURE? (MULTIPLE RESPONSE)

CORVALLIS
STORMWATER SURVEY
JANUARY, 1998

		GENDER		AGE			EDUCATION			RESIDENCE		AREA				RESIDENCY	
	TOTAL	MALE	FEMALE	18-34	35-54	55PLUS	HIGH/ LESS	SOME COLLEG	COLLEG GRAD	OWN	RENT	NORTH EAST	NORTH WEST	SOUTH EAST	SOUTH WEST	<10YRS	10YRS>
TOTAL RESPONDENTS	366	184	182	100	158	102	62	105	195	230	129	34	217	27	75	176	188
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
DON'T KNOW	41	12	29	10	11	18	13	13	15	22	18	6	25	2	6	21	19
	11%	7%	16%	10%	7%	18%	21%	12%	8%	10%	14%	18%	12%	7%	8%	12%	10%

MCARTHUR ASSOCIATES
(503) 228-5565

32. WHO SHOULD BE PRIMARILY RESPONSIBLE FOR TAKING ACTIONS IN OUR COMMUNITY TO ENHANCE URBAN STREAMS OR BETTER MANAGE STORMWATER DRAINAGE PROBLEMS IN THE FUTURE? (MULTIPLE RESPONSE)

		--UNRESOLVED-		-AFFEC FLOOD-		------STORMWATER BILL------			
	TOTAL	YES	NO/DK	YES	NO	HIGH	RIGHT	LOW	DK/NOP
TOTAL RESPONDENTS	366 100%	170 100%	196 100%	136 100%	230 100%	54 100%	120 100%	28 100%	164 100%
DON'T KNOW	41 11%	16 9%	25 13%	13 10%	28 12%	6 11%	15 13%	2 7%	18 11%

MCARTHUR ASSOCIATES
(503) 228-5565

33. CORVALLIS RESIDENTS AND PROPERTY OWNERS CURRENTLY PAY FOR STORMWATER MANAGEMENT SERVICES THROUGH A MONTHLY UTILITY FEE THAT IS INCLUDED WITH THE WATER AND SEWER BILL. HOW MUCH DOES YOUR HOUSEHOLD PAY PER MONTH?

CORVALLIS
STORMWATER SURVEY
JANUARY, 1998

	TOTAL	GENDER: MALE	GENDER: FEMALE	AGE: 18-34	AGE: 35-54	AGE: 55PLUS	EDUCATION: HIGH/ LESS	EDUCATION: SOME COLLEG	EDUCATION: COLLEG GRAD	RESIDENCE: OWN	RESIDENCE: RENT	AREA: NORTH EAST	AREA: NORTH WEST	AREA: SOUTH EAST	AREA: SOUTH WEST	RESIDENCY: <10YRS	RESIDENCY: 10YRS>
TOTAL RESPONDENTS	366	184	182	100	158	102	62	105	195	230	129	34	217	27	75	176	188
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
LESS THAN $1	5	4	1	0	5	0	1	1	3	4	1	2	1	0	2	1	4
	1%	2%	1%		3%		2%	1%	2%	2%	1%	6%	*		3%	1%	2%
$1 TO $2.99	12	9	3	2	5	5	2	1	9	10	1	1	5	2	4	5	7
	3%	5%	2%	2%	3%	5%	3%	1%	5%	4%	1%	3%	2%	7%	5%	3%	4%
$3 TO $10	27	12	15	6	16	5	2	10	15	23	4	3	14	3	7	9	18
	7%	7%	8%	6%	10%	5%	3%	10%	8%	10%	3%	9%	6%	11%	9%	5%	10%
OVER $10	76	37	39	11	40	24	15	16	45	65	11	5	54	6	11	30	46
	21%	20%	21%	11%	25%	24%	24%	15%	23%	28%	9%	15%	25%	22%	15%	17%	24%
DON'T KNOW/NOT SURE	246	122	124	81	92	68	42	77	123	128	112	23	143	16	51	131	113
	67%	66%	68%	81%	58%	67%	68%	73%	63%	56%	87%	68%	66%	59%	68%	74%	60%

33. CORVALLIS RESIDENTS AND PROPERTY OWNERS CURRENTLY PAY FOR STORMWATER MANAGEMENT SERVICES THROUGH A MONTHLY UTILITY FEE THAT IS INCLUDED WITH THE WATER AND SEWER BILL. HOW MUCH DOES YOUR HOUSEHOLD PAY PER MONTH?

		--UNRESOLVED-		-AFFEC FLOOD-		------STORMWATER BILL------			
	TOTAL	YES	NO/DK	YES	NO	HIGH	RIGHT	LOW	DK/NOP
TOTAL RESPONDENTS	366 100%	170 100%	196 100%	136 100%	230 100%	54 100%	120 100%	28 100%	164 100%
LESS THAN $1	5 1%	4 2%	1 1%	2 1%	3 1%	0	0	1 4%	4 2%
$1 TO $2.99	12 3%	3 2%	9 5%	3 2%	9 4%	1 2%	8 7%	2 7%	1 1%
$3 TO $10	27 7%	16 9%	11 6%	15 11%	12 5%	6 11%	12 10%	5 18%	4 2%
OVER $10	76 21%	41 24%	35 18%	34 25%	42 18%	21 39%	39 33%	5 18%	11 7%
DON'T KNOW/NOT SURE	246 67%	106 62%	140 71%	82 60%	164 71%	26 48%	61 51%	15 54%	144 88%

34. CURRENTLY, DO YOU FEEL THAT YOUR STORMWATER DRAINAGE BILLS ARE TOO HIGH FOR THE SERVICE PROVIDED, ABOUT RIGHT FOR THE SERVICE PROVIDED, OR RELATIVELY LOW FOR THE SERVICE PROVIDED?

CORVALLIS
STORMWATER SURVEY
JANUARY, 1998

		GENDER		AGE			EDUCATION			RESIDENCE		AREA				RESIDENCY	
	TOTAL	MALE	FEMALE	18-34	35-54	55PLUS	HIGH/ LESS	SOME COLLEG	COLLEG GRAD	OWN	RENT	NORTH EAST	NORTH WEST	SOUTH EAST	SOUTH WEST	<10YRS	10YRS>
TOTAL RESPONDENTS	366	184	182	100	158	102	62	105	195	230	129	34	217	27	75	176	188
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
TOO HIGH FOR THE SERVICE PROVIDED	54	32	22	11	25	17	12	16	26	39	14	3	32	5	12	15	39
	15%	17%	12%	11%	16%	17%	19%	15%	13%	17%	11%	9%	15%	19%	16%	9%	21%
ABOUT RIGHT FOR THE SERVICE PROVIDED	120	58	62	24	54	41	18	25	75	88	29	4	86	10	17	51	67
	33%	32%	34%	24%	34%	40%	29%	24%	38%	38%	22%	12%	40%	37%	23%	29%	36%
RELATIVELY LOW FOR THE SERVICE PROVIDED	28	17	11	7	14	6	6	4	18	20	8	6	16	1	5	16	12
	8%	9%	6%	7%	9%	6%	10%	4%	9%	9%	6%	18%	7%	4%	7%	9%	6%
DON'T KNOW/NO OPINION	164	77	87	58	65	38	26	60	76	83	78	21	83	11	41	94	70
	45%	42%	48%	58%	41%	37%	42%	57%	39%	36%	60%	62%	38%	41%	55%	53%	37%

MCARTHUR ASSOCIATES
(503) 228-5565

34. CURRENTLY, DO YOU FEEL THAT YOUR STORMWATER DRAINAGE BILLS ARE TOO HIGH FOR THE SERVICE PROVIDED, ABOUT RIGHT FOR THE SERVICE PROVIDED, OR RELATIVELY LOW FOR THE SERVICE PROVIDED?

		--UNRESOLVED-		-AFFEC FLOOD-		------STORMWATER BILL------			
	TOTAL	YES	NO/DK	YES	NO	HIGH	RIGHT	LOW	DK/NOP
TOTAL RESPONDENTS	366 100%	170 100%	196 100%	136 100%	230 100%	54 100%	120 100%	28 100%	164 100%
TOO HIGH FOR THE SERVICE PROVIDED	54 15%	30 18%	24 12%	19 14%	35 15%	54 100%	0	0	0
ABOUT RIGHT FOR THE SERVICE PROVIDED	120 33%	56 33%	64 33%	48 35%	72 31%	0	120 100%	0	0
RELATIVELY LOW FOR THE SERVICE PROVIDED	28 8%	15 9%	13 7%	13 10%	15 7%	0	0	28 100%	0
DON'T KNOW/NO OPINION	164 45%	69 41%	95 48%	56 41%	108 47%	0	0	0	164 100%

MCARTHUR ASSOCIATES
(503) 228-5565

35. AFTER I NAME THREE POSSIBLE WAYS OF PAYING FOR IMPROVED STORMWATER MANAGEMENT, PLEASE TELL ME WHICH YOU THINK IS THE BEST WAY FOR THE PEOPLE IN CORVALLIS?

CORVALLIS
STORMWATER SURVEY
JANUARY, 1998

		GENDER		AGE			EDUCATION			RESIDENCE		AREA				RESIDENCY	
	TOTAL	MALE	FEMALE	18-34	35-54	55PLUS	HIGH/ LESS	SOME COLLEG	COLLEG GRAD	OWN	RENT	NORTH EAST	NORTH WEST	SOUTH EAST	SOUTH WEST	<10YRS	10YRS>
TOTAL RESPONDENTS	366 100%	184 100%	182 100%	100 100%	158 100%	102 100%	62 100%	105 100%	195 100%	230 100%	129 100%	34 100%	217 100%	27 100%	75 100%	176 100%	188 100%
COLLECTING MONEY THROUGH A COMBINATION/MONTHLY UTILITY RATES/NEW DEVELOPMENT FEES	262 72%	130 71%	132 73%	72 72%	114 72%	73 72%	39 63%	78 74%	142 73%	162 70%	94 73%	21 62%	158 73%	20 74%	57 76%	126 72%	134 71%
COLLECTING MONEY EXCLUSIVELY BY CHARGING FEES FOR NEW DEVELOPMENT	45 12%	24 13%	21 12%	13 13%	19 12%	12 12%	5 8%	15 14%	25 13%	33 14%	11 9%	3 9%	31 14%	2 7%	7 9%	19 11%	26 14%
COLLECTING MONEY EXCLUSIVELY THROUGH MONTHLY UTILITY RATES PAID BY ALL CUSTOMERS	38 10%	19 10%	19 10%	15 15%	16 10%	7 7%	12 19%	8 8%	18 9%	20 9%	18 14%	6 18%	19 9%	5 19%	7 9%	26 15%	12 6%
NONE	11 3%	8 4%	3 2%	0	7 4%	4 4%	3 5%	3 3%	4 2%	9 4%	2 2%	1 3%	5 2%	0	4 5%	3 2%	8 4%
DON'T KNOW/NOT SURE	10 3%	3 2%	7 4%	0	2 1%	6 6%	3 5%	1 1%	6 3%	6 3%	4 3%	3 9%	4 2%	0	0	2 1%	8 4%

MCARTHUR ASSOCIATES
(503) 228-5565

35. AFTER I NAME THREE POSSIBLE WAYS OF PAYING FOR IMPROVED STORMWATER MANAGEMENT, PLEASE TELL ME WHICH YOU THINK IS THE BEST WAY FOR THE PEOPLE IN CORVALLIS?

		--UNRESOLVED-		-AFFEC FLOOD-		------STORMWATER BILL------			
	TOTAL	YES	NO/DK	YES	NO	HIGH	RIGHT	LOW	DK/NOP
TOTAL RESPONDENTS	366 100%	170 100%	196 100%	136 100%	230 100%	54 100%	120 100%	28 100%	164 100%
COLLECTING MONEY THROUGH A COMBINATION/MONTHLY UTILITY RATES/NEW DEVELOPMENT FEES	262 72%	124 73%	138 70%	105 77%	157 68%	32 59%	90 75%	25 89%	115 70%
COLLECTING MONEY EXCLUSIVELY BY CHARGING FEES FOR NEW DEVELOPMENT	45 12%	23 14%	22 11%	17 13%	28 12%	15 28%	18 15%	1 4%	11 7%
COLLECTING MONEY EXCLUSIVELY THROUGH MONTHLY UTILITY RATES PAID BY ALL CUSTOMERS	38 10%	17 10%	21 11%	10 7%	28 12%	1 2%	11 9%	2 7%	24 15%
NONE	11 3%	6 4%	5 3%	0	11 5%	6 11%	1 1%	0	4 2%
DON'T KNOW/NOT SURE	10 3%	0	10 5%	4 3%	6 3%	0	0	0	10 6%

MCARTHUR ASSOCIATES
(503) 228-5565

36. FINALLY, FOR OUR ANALYSIS OF THIS SURVEY, WOULD YOU GIVE US A LITTLE INFORMATION ABOUT YOURSELF. ALL OF YOUR ANSWERS WILL BE CONFIDENTIAL. WHAT IS YOUR AGE?

CORVALLIS
STORMWATER SURVEY
JANUARY, 1998

		---GENDER----		--------AGE---------			------EDUCATION-----			--RESIDENCE--		-----------AREA-----------				--RESIDENCY--	
	TOTAL	MALE	FEMALE	18-34	35-54	55PLUS	HIGH/ LESS	SOME COLLEG	COLLEG GRAD	OWN	RENT	NORTH EAST	NORTH WEST	SOUTH EAST	SOUTH WEST	<10YRS	10YRS>
TOTAL RESPONDENTS	366 100%	184 100%	182 100%	100 100%	158 100%	102 100%	62 100%	105 100%	195 100%	230 100%	129 100%	34 100%	217 100%	27 100%	75 100%	176 100%	188 100%
18-34	100 27%	52 28%	48 26%	100 100%	0	0	11 18%	56 53%	32 16%	20 9%	77 60%	10 29%	55 25%	6 22%	24 32%	80 45%	20 11%
35-54	158 43%	81 44%	77 42%	0	158 100%	0	25 40%	28 27%	104 53%	122 53%	35 27%	15 44%	95 44%	16 59%	28 37%	73 41%	85 45%
55 AND OVER	102 28%	48 26%	54 30%	0	0	102 100%	26 42%	20 19%	55 28%	84 37%	16 12%	7 21%	65 30%	5 19%	23 31%	23 13%	78 41%
REFUSED	6 2%	3 2%	3 2%	0	0	0	0	1 1%	4 2%	4 2%	1 1%	2 6%	2 1%	0	0	0	5 3%

MCARTHUR ASSOCIATES
(503) 228-5565

36. FINALLY, FOR OUR ANALYSIS OF THIS SURVEY, WOULD YOU GIVE US A LITTLE INFORMATION ABOUT YOURSELF. ALL OF YOUR ANSWERS WILL BE CONFIDENTIAL. WHAT IS YOUR AGE?

		--UNRESOLVED-		-AFFEC FLOOD-		------STORMWATER BILL------			
	TOTAL	YES	NO/DK	YES	NO	HIGH	RIGHT	LOW	DK/NOP
TOTAL RESPONDENTS	366 100%	170 100%	196 100%	136 100%	230 100%	54 100%	120 100%	28 100%	164 100%
18-34	100 27%	47 28%	53 27%	40 29%	60 26%	11 20%	24 20%	7 25%	58 35%
35-54	158 43%	85 50%	73 37%	62 46%	96 42%	25 46%	54 45%	14 50%	65 40%
55 AND OVER	102 28%	35 21%	67 34%	29 21%	73 32%	17 31%	41 34%	6 21%	38 23%
REFUSED	6 2%	3 2%	3 2%	5 4%	1 *	1 2%	1 1%	1 4%	3 2%

MCARTHUR ASSOCIATES
(503) 228-5565

37. WHAT IS THE FINAL YEAR OF SCHOOL YOU COMPLETED?

CORVALLIS
STORMWATER SURVEY
JANUARY, 1998

		GENDER		AGE			EDUCATION			RESIDENCE		AREA				RESIDENCY	
	TOTAL	MALE	FEMALE	18-34	35-54	55PLUS	HIGH/ LESS	SOME COLLEG	COLLEG GRAD	OWN	RENT	NORTH EAST	NORTH WEST	SOUTH EAST	SOUTH WEST	<10YRS	10YRS>
TOTAL RESPONDENTS	366	184	182	100	158	102	62	105	195	230	129	34	217	27	75	176	188
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
LESS THAN 12 YEARS	10	6	4	1	3	6	10	0	0	4	6	1	7	0	1	5	5
	3%	3%	2%	1%	2%	6%	16%			2%	5%	3%	3%		1%	3%	3%
HIGH SCHOOL GRADUATE	52	25	27	10	22	20	52	0	0	32	17	9	28	6	9	25	27
	14%	14%	15%	10%	14%	20%	84%			14%	13%	26%	13%	22%	12%	14%	14%
SOME COLLEGE	105	44	61	56	28	20	0	105	0	47	56	11	55	10	24	57	47
	29%	24%	34%	56%	18%	20%		100%		20%	43%	32%	25%	37%	32%	32%	25%
BACHELOR'S DEGREE	76	38	38	19	41	14	0	0	76	51	24	4	47	5	19	34	42
	21%	21%	21%	19%	26%	14%			39%	22%	19%	12%	22%	19%	25%	19%	22%
POST-GRADUATE CLASSES	39	26	13	7	16	15	0	0	39	28	11	3	23	2	9	19	20
	11%	14%	7%	7%	10%	15%			20%	12%	9%	9%	11%	7%	12%	11%	11%
POST-GRADUATE DEGREE	80	42	38	6	47	26	0	0	80	65	15	6	56	4	11	33	47
	22%	23%	21%	6%	30%	25%			41%	28%	12%	18%	26%	15%	15%	19%	25%
REFUSED	4	3	1	1	1	1	0	0	0	3	0	0	1	0	2	3	0
	1%	2%	1%	1%	1%	1%				1%			*		3%	2%	

MCARTHUR ASSOCIATES
(503) 228-5565

37. WHAT IS THE FINAL YEAR OF SCHOOL YOU COMPLETED?

		--UNRESOLVED-		-AFFEC FLOOD-		------STORMWATER BILL------			
	TOTAL	YES	NO/DK	YES	NO	HIGH	RIGHT	LOW	DK/NOP
TOTAL RESPONDENTS	366	170	196	136	230	54	120	28	164
	100%	100%	100%	100%	100%	100%	100%	100%	100%
LESS THAN 12 YEARS	10	4	6	2	8	1	5	0	4
	3%	2%	3%	1%	3%	2%	4%		2%
HIGH SCHOOL GRADUATE	52	13	39	10	42	11	13	6	22
	14%	8%	20%	7%	18%	20%	11%	21%	13%
SOME COLLEGE	105	47	58	51	54	16	25	4	60
	29%	28%	30%	38%	23%	30%	21%	14%	37%
BACHELOR'S DEGREE	76	36	40	27	49	13	34	7	22
	21%	21%	20%	20%	21%	24%	28%	25%	13%
POST-GRADUATE CLASSES	39	22	17	13	26	3	14	2	20
	11%	13%	9%	10%	11%	6%	12%	7%	12%
POST-GRADUATE DEGREE	80	45	35	32	48	10	27	9	34
	22%	26%	18%	24%	21%	19%	23%	32%	21%
REFUSED	4	3	1	1	3	0	2	0	2
	1%	2%	1%	1%	1%		2%		1%

MCARTHUR ASSOCIATES
(503) 228-5565

38. DO YOU OWN YOUR OWN HOME OR ARE YOU RENTING?

CORVALLIS
STORMWATER SURVEY
JANUARY, 1998

		GENDER		AGE			EDUCATION			RESIDENCE		AREA				RESIDENCY	
	TOTAL	MALE	FEMALE	18-34	35-54	55PLUS	HIGH/ LESS	SOME COLLEG	COLLEG GRAD	OWN	RENT	NORTH EAST	NORTH WEST	SOUTH EAST	SOUTH WEST	<10YRS	10YRS>
TOTAL RESPONDENTS	366 100%	184 100%	182 100%	100 100%	158 100%	102 100%	62 100%	105 100%	195 100%	230 100%	129 100%	34 100%	217 100%	27 100%	75 100%	176 100%	188 100%
OWN	230 63%	117 64%	113 62%	20 20%	122 77%	84 82%	36 58%	47 45%	144 74%	230 100%	0	17 50%	138 64%	19 70%	48 64%	82 47%	147 78%
RENT	129 35%	61 33%	68 37%	77 77%	35 22%	16 16%	23 37%	56 53%	50 26%	0	129 100%	16 47%	77 35%	7 26%	25 33%	92 52%	37 20%
OTHER	4 1%	3 2%	1 1%	1 1%	1 1%	2 2%	2 3%	1 1%	1 1%	0	0	0	2 1%	1 4%	1 1%	2 1%	2 1%
REFUSED	3 1%	3 2%	0	2 2%	0	0	1 2%	1 1%	0	0	0	1 3%	0	0	1 1%	0	2 1%

MCARTHUR ASSOCIATES
(503) 228-5565

38. DO YOU OWN YOUR OWN HOME OR ARE YOU RENTING?

		--UNRESOLVED-		-AFFEC FLOOD-		------STORMWATER BILL------			
	TOTAL	YES	NO/DK	YES	NO	HIGH	RIGHT	LOW	DK/NOP
TOTAL RESPONDENTS	366 100%	170 100%	196 100%	136 100%	230 100%	54 100%	120 100%	28 100%	164 100%
OWN	230 63%	106 62%	124 63%	83 61%	147 64%	39 72%	88 73%	20 71%	83 51%
RENT	129 35%	62 36%	67 34%	49 36%	80 35%	14 26%	29 24%	8 29%	78 48%
OTHER	4 1%	1 1%	3 2%	2 1%	2 1%	1 2%	2 2%	0	1 1%
REFUSED	3 1%	1 1%	2 1%	2 1%	1 *	0	1 1%	0	2 1%

39. IN WHAT AREA OF CORVALLIS DO YOU RESIDE?

CORVALLIS
STORMWATER SURVEY
JANUARY, 1998

		---GENDER----		--------AGE---------			------EDUCATION-----			--RESIDENCE--		-----------AREA-----------				--RESIDENCY--	
	TOTAL	MALE	FEMALE	18-34	35-54	55PLUS	HIGH/ LESS	SOME COLLEG	COLLEG GRAD	OWN	RENT	NORTH EAST	NORTH WEST	SOUTH EAST	SOUTH WEST	<10YRS	10YRS>
TOTAL RESPONDENTS	366	184	182	100	158	102	62	105	195	230	129	34	217	27	75	176	188
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
NORTHEAST	34	13	21	10	15	7	10	11	13	17	16	34	0	0	0	19	15
	9%	7%	12%	10%	9%	7%	16%	10%	7%	7%	12%	100%				11%	8%
NORTHWEST	217	108	109	55	95	65	35	55	126	138	77	0	217	0	0	105	112
	59%	59%	60%	55%	60%	64%	56%	52%	65%	60%	60%		100%			60%	60%
SOUTHEAST	27	15	12	6	16	5	6	10	11	19	7	0	0	27	0	8	19
	7%	8%	7%	6%	10%	5%	10%	10%	6%	8%	5%			100%		5%	10%
SOUTHWEST	75	39	36	24	28	23	10	24	39	48	25	0	0	0	75	39	36
	20%	21%	20%	24%	18%	23%	16%	23%	20%	21%	19%				100%	22%	19%
REFUSED	13	9	4	5	4	2	1	5	6	8	4	0	0	0	0	5	6
	4%	5%	2%	5%	3%	2%	2%	5%	3%	3%	3%					3%	3%

MCARTHUR ASSOCIATES
(503) 228-5565

39. IN WHAT AREA OF CORVALLIS DO YOU RESIDE?

		--UNRESOLVED-		-AFFEC FLOOD-		------STORMWATER BILL------			
	TOTAL	YES	NO/DK	YES	NO	HIGH	RIGHT	LOW	DK/NOP
TOTAL RESPONDENTS	366 100%	170 100%	196 100%	136 100%	230 100%	54 100%	120 100%	28 100%	164 100%
NORTHEAST	34 9%	17 10%	17 9%	12 9%	22 10%	3 6%	4 3%	6 21%	21 13%
NORTHWEST	217 59%	98 58%	119 61%	71 52%	146 63%	32 59%	86 72%	16 57%	83 51%
SOUTHEAST	27 7%	15 9%	12 6%	21 15%	6 3%	5 9%	10 8%	1 4%	11 7%
SOUTHWEST	75 20%	34 20%	41 21%	26 19%	49 21%	12 22%	17 14%	5 18%	41 25%
REFUSED	13 4%	6 4%	7 4%	6 4%	7 3%	2 4%	3 3%	0	8 5%

MCARTHUR ASSOCIATES
(503) 228-5565

40. FOR ABOUT HOW MANY YEARS HAVE YOU LIVED IN CORVALLIS?

CORVALLIS
STORMWATER SURVEY
JANUARY, 1998

		GENDER		AGE			EDUCATION			RESIDENCE		AREA				RESIDENCY	
	TOTAL	MALE	FEMALE	18-34	35-54	55PLUS	HIGH/ LESS	SOME COLLEG	COLLEG GRAD	OWN	RENT	NORTH EAST	NORTH WEST	SOUTH EAST	SOUTH WEST	<10YRS	10YRS>
TOTAL RESPONDENTS	366	184	182	100	158	102	62	105	195	230	129	34	217	27	75	176	188
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
LESS THAN 10 YEARS	176	83	93	80	73	23	30	57	86	82	92	19	105	8	39	176	0
	48%	45%	51%	80%	46%	23%	48%	54%	44%	36%	71%	56%	48%	30%	52%	100%	
10 YEARS OR MORE	188	100	88	20	85	78	32	47	109	147	37	15	112	19	36	0	188
	51%	54%	48%	20%	54%	76%	52%	45%	56%	64%	29%	44%	52%	70%	48%		100%
REFUSED	2	1	1	0	0	1	0	1	0	1	0	0	0	0	0	0	0
	1%	1%	1%			1%		1%		*							

MCARTHUR ASSOCIATES
(503) 228-5565

40. FOR ABOUT HOW MANY YEARS HAVE YOU LIVED IN CORVALLIS?

		--UNRESOLVED-		-AFFEC FLOOD-		------STORMWATER BILL------			
	TOTAL	YES	NO/DK	YES	NO	HIGH	RIGHT	LOW	DK/NOP
TOTAL RESPONDENTS	366 100%	170 100%	196 100%	136 100%	230 100%	54 100%	120 100%	28 100%	164 100%
LESS THAN 10 YEARS	176 48%	76 45%	100 51%	55 40%	121 53%	15 28%	51 43%	16 57%	94 57%
10 YEARS OR MORE	188 51%	93 55%	95 48%	80 59%	108 47%	39 72%	67 56%	12 43%	70 43%
REFUSED	2 1%	1 1%	1 1%	1 1%	1 *	0	2 2%	0	0

MCARTHUR ASSOCIATES
(503) 228-5565

41. ARE YOU A FULL TIME COLLEGE STUDENT?

CORVALLIS
STORMWATER SURVEY
JANUARY, 1998

		GENDER		AGE			EDUCATION			RESIDENCE		AREA				RESIDENCY	
	TOTAL	MALE	FEMALE	18-34	35-54	55PLUS	HIGH/ LESS	SOME COLLEG	COLLEG GRAD	OWN	RENT	NORTH EAST	NORTH WEST	SOUTH EAST	SOUTH WEST	<10YRS	10YRS>
TOTAL RESPONDENTS	366	184	182	100	158	102	62	105	195	230	129	34	217	27	75	176	188
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
YES	46	27	19	42	3	1	3	32	11	5	39	5	23	1	14	40	6
	13%	15%	10%	42%	2%	1%	5%	30%	6%	2%	30%	15%	11%	4%	19%	23%	3%
NO	320	157	163	58	155	101	59	73	184	225	90	29	194	26	61	136	182
	87%	85%	90%	58%	98%	99%	95%	70%	94%	98%	70%	85%	89%	96%	81%	77%	97%

MCARTHUR ASSOCIATES
(503) 228-5565

41. ARE YOU A FULL TIME COLLEGE STUDENT?

		--UNRESOLVED-		-AFFEC FLOOD-		------STORMWATER BILL------			
	TOTAL	YES	NO/DK	YES	NO	HIGH	RIGHT	LOW	DK/NOP
TOTAL RESPONDENTS	366 100%	170 100%	196 100%	136 100%	230 100%	54 100%	120 100%	28 100%	164 100%
YES	46 13%	20 12%	26 13%	16 12%	30 13%	7 13%	8 7%	1 4%	30 18%
NO	320 87%	150 88%	170 87%	120 88%	200 87%	47 87%	112 93%	27 96%	134 82%

MCARTHUR ASSOCIATES
(503) 228-5565

42. GENDER:

CORVALLIS
STORMWATER SURVEY
JANUARY, 1998

		GENDER		AGE			EDUCATION			RESIDENCE		AREA				RESIDENCY	
	TOTAL	MALE	FEMALE	18-34	35-54	55PLUS	HIGH/ LESS	SOME COLLEG	COLLEG GRAD	OWN	RENT	NORTH EAST	NORTH WEST	SOUTH EAST	SOUTH WEST	<10YRS	10YRS>
TOTAL RESPONDENTS	366	184	182	100	158	102	62	105	195	230	129	34	217	27	75	176	188
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
MALE	184	184	0	52	81	48	31	44	106	117	61	13	108	15	39	83	100
	50%	100%		52%	51%	47%	50%	42%	54%	51%	47%	38%	50%	56%	52%	47%	53%
FEMALE	182	0	182	48	77	54	31	61	89	113	68	21	109	12	36	93	88
	50%		100%	48%	49%	53%	50%	58%	46%	49%	53%	62%	50%	44%	48%	53%	47%

42. GENDER:

		--UNRESOLVED-		-AFFEC FLOOD-		------STORMWATER BILL------			
	TOTAL	YES	NO/DK	YES	NO	HIGH	RIGHT	LOW	DK/NOP
TOTAL RESPONDENTS	366 100%	170 100%	196 100%	136 100%	230 100%	54 100%	120 100%	28 100%	164 100%
MALE	184 50%	90 53%	94 48%	62 46%	122 53%	32 59%	58 48%	17 61%	77 47%
FEMALE	182 50%	80 47%	102 52%	74 54%	108 47%	22 41%	62 52%	11 39%	87 53%

Corvallis Stormwater Master Plan

Summary of Stakeholder Interviews

Prepared for:

City of Corvallis
Stormwater Planning Committee

Prepared by:

Barney & Worth, Inc.
1211 SW Fifth Ave., Suite 2100
Portland, OR 97204
Phone (503) 222-0146
Fax (503) 274-7955

In association with:

Brown and Caldwell

January 1998

Table of Contents

Page

VII. Other Advice

VIII. Appendices

I. Executive Summary

Corvallis Stormwater Master Plan

In 1997, the City of Corvallis engaged a multi-disciplinary consultant team headed by the engineering firm Brown and Caldwell to recommend how to control flooding and manage other stormwater problems. The Corvallis Stormwater Master Plan is scheduled to be completed, and recommendations presented to the Corvallis City Council in 1999.

Stakeholder Interviews

In December 1997 and January 1998, community leaders and other key "stakeholders" were surveyed to seek their views on many important issues linked to the Corvallis Stormwater Master Plan. Interviews were conducted in-person and by telephone with some 50 community leaders and other persons who are involved in community affairs or may be affected by stormwater issues. Participants were asked to share their views related to: stormwater issues; the nature and severity of flooding problems, causes and possible solutions; values and principles to guide decisionmaking; costs; and citizen participation (a list of interview questions is attached in an appendix).

The list of persons to be interviewed, along with the survey questions, were developed in collaboration with the Corvallis Stormwater Planning Committee.

Among the persons interviewed were representatives of Corvallis neighborhood associations, environmental/clean water advocates, developers and home-builders, business community leaders and large employers, regulatory / resource agency personnel, members of City Council, and area residents and property owners in affected watersheds (see attached list in an appendix). Members of the Corvallis Stormwater Planning Committee were also interviewed, with the results separated from other interviews. This report reflects the feelings and attitudes of those individuals interviewed, and is not intended to provide a scientifically valid profile of the community as a whole.

Summary of Findings

A summary of key points offered by the community leaders and other interested citizens who were interviewed regarding the Corvallis Stormwater Master Plan:

1. **Flooding is not the main problem.** The inundation of local homes and streets is rather a symptom of problems, according to most interview participants. Historic development patterns in Corvallis have produced substantial development in the floodplain, and in stream corridors which are also impacted by flooding on occasion. As Corvallis has grown, so has the amount of impervious surface, with high velocity storm flows channeled from pipes into urban streams, contributing further to the problem.

2. **Observers remain open to many options for addressing stormwater issues**, and want more information. Stakeholders say that in many cases, the right solution to stormwater problems must be tailored to the watershed or even site-specific. A

strong emphasis is placed on solutions which retain stormwater on-site and enhance water quality.

3. **Multiple-benefit and "natural" solutions are preferred.** Most community leaders interviewed aren't ready to pinpoint the best solution. However, they prefer approaches that promise to fulfill multiple objectives: enhancing habitat and providing recreational opportunities, for example, while also improving stormwater management.

4. **Key stakeholders favor a basin-by-basin approach** to stormwater planning. Each stream, watershed and neighborhood is said to have its own unique characteristics. Designing the most effective stormwater system must respect and draw upon these differences. The basin-by-basin approach is also envisioned to boost citizen interest and participation, using a stormwater planning process that brings the issues "close to home" for Corvallis residents.

5. **The City of Corvallis and other public agencies should show the way.** Key parcels of land in Corvallis are in public ownership, it is noted. Stakeholders suggest that the City of Corvallis, OSU and other agencies should "set an example," demonstrating good stewardship of their own properties, providing positive examples of urban stream protection and on-site stormwater management. The City is also in a unique leadership position, able to set and enforce development standards that protect streams.

6. **Costs of stormwater system improvements should be equitably shared** by existing ratepayers and new development. While cost is not yet a major concern, key stakeholders suspect that stormwater drainage fees will rise in the future. Consensus is that new development should contribute significantly, through SDCs or other methods, to offset or cover costs for new infrastructure serving newly developed areas.

7. **Public outreach for stormwater issues should target lay citizens.** Key stakeholders reason that stormwater issues affect everyone in the community. Citizens will also be counted on to pitch in and help implement solutions – so their understanding and involvement are crucial. There's also a recognition that some groups are particularly important to involve, particularly developers. Other potentially interested and affected groups to target for outreach include: neighborhood associations, environmental groups, large landowners, farmers and other property owners upstream and downstream from Corvallis, and residents who live near streams. The best outreach methods are said to be those which reach wide audiences: direct mailings, newspaper, and City newsletter.

8. **Gaining broad-based citizen understanding of stormwater issues will require a long-term commitment to public education.** Stormwater is not a top-of-mind issue for the average citizen, key stakeholders say. While high water in recent years has brought more attention to stormwater problems, this hasn't translated into broad-based understanding of the issues at stake or options for the future. The outstanding pool of scientists and other specialists who live in Corvallis represents a unique resource to be tapped for this ongoing community education process, local leaders observe.

9. **The Corvallis Stormwater Master Plan should provide solid guidance for managing stormwater while maintaining and enhancing livability.** There is a high expectation in the community that the Stormwater Master Plan will yield a strategy which balances well-planned urban growth with key livability issues including environmental protection and conservation, aesthetics, affordability, and economic vitality.

The next sections provide a more detailed discussion of the results of stakeholder interviews for the Corvallis Stormwater Master Plan.

II. Stormwater Issues in Corvallis

At the opening of each interview, participants were asked to describe their personal involvement and impressions of stormwater issues and problems.

Familiarity with Area Streams

Do key stakeholders live near a stream? Are they more familiar with certain streams?

Most interview participants report they live near streams, and say they are familiar with one or more streams:

- The streams which are *closest to homes* of most participants are the Mary's River, Oak Creek, and Dixon Creek. Other participants say they live near: the Willamette River, Sequoia Creek, Jackson / Frazier Creek, Squaw Creek, Muddy Creek, and Stewart Slough.

- The streams which are *most familiar* are Mary's River, Oak Creek, and Dixon Creek. Other streams familiar to several participants include Willamette River, Jackson / Frazier Creek and Squaw Creek.

Personal Involvement with Stormwater Issues

How have stakeholders been involved in Corvallis stormwater issues in the past, and what are their general impressions?

Most of the stakeholders interviewed say they have become more aware of stormwater issues in recent years. "My impression is that Corvallis is waking up to these issues, given what's been happening with flooding and increases in drainage rates," notes one participant.

A number of the persons interviewed have also become directly involved in stormwater, due to flooding on their property, through their participation in the CSO (combined sewer overflow) program, or other local watershed basin planning efforts.

Key Stormwater Issues and Their Importance

Stakeholders were asked whether they perceive a "problem" with stormwater in Corvallis, and which top issues are of most importance for the City of Corvallis to address in the Stormwater Master Plan. Most respondents agree there is a stormwater problem and suggest the plan needs to address:

- How to handle peak flows during heavy rainfall periods
- The appropriate role of urban streams in the city-wide drainage system: "the perception is that urban streams are ditches"
- The relationship between stormwater and Corvallis' CSO problem
- Impacts from increased development: greater stormwater quantity and velocity
- Future flooding potential and associated risks to public safety and property

- Stormwater quality
- Cost

Participants were also asked to evaluate whether a series of specific stormwater issues are important to address in the Master Plan. The most important issues, in the eyes of stakeholders, are water quality and erosion.

Other issues rated as "very important" or "important" by most participants include:

- Flooding of streets, homes and businesses
- Rapid runoff from development
- Loss of stream habitat

Stormwater issues deemed somewhat less important include:

- Development in floodplains
- Use of streams to drain urban runoff
- Cost, and equitable sharing of costs
- Development standards and enforcement
- Growth management

Other issues suggested by participants to be addressed in the Stormwater Master Plan:

- Cost-effectiveness
- Restoration of natural systems / waterways
- Need for basin-wide planning in each stream corridor, inside and outside the UGB
- Impacts on streams of pesticides and herbicides
- Public education

A number of observers believe that stormwater problems in Corvallis are not particularly unique. Serious stormwater problems in the community – such as the recent flooding – are said to be "occasional" or "unusual" or "not a real big problem."

Personal Experience with Flooding

Interview participants were invited to share their personal experiences with flooding, and were asked for their opinions on what factors may contribute to the flooding.

Very few interview participants have experienced flooding in their own home or business. Several report flooding on their property, particularly those in agricultural areas or in the floodplain.

Nearly all stakeholders, however, say they are familiar with flooding problems in the Corvallis area. Most say they have had to change their travel routine to avoid flooded roads or bridges, or have friends who have experienced flooding in their homes.

Specific reports of flooding on public and private property include inundated and closed bridges and streets, flooded school yards, problem spots in the downtown and South Corvallis, damage to crops, and some flooded homes and businesses.

Interview participants, however, are more concerned about the threat of future flooding. They say that development continues in stream corridors, and higher water levels are encroaching more frequently on private property. Stakeholders observe that area citizens are "more worried about future flooding" if a long-term solution is not found.

Origin of Flooding Problems; Contributing Factors

The origin of flooding reported most frequently: streams overflowing their banks during periods of heavy rain. Other contributing factors mentioned include increased runoff from growing areas of impervious surface, sewage and stormwater backing up into basements, and artificial structures diverting flows out of streams.

New development in upstream areas of Corvallis is also suspected by many stakeholders to be a contributing factor. However, other observers – including some long-time area residents – debate this point. They recall that Corvallis experienced flooding before the recent development occurred.

III. Possible Solutions to Stormwater Problems

The stakeholder interviews also explored possible remedies to the community's stormwater problems.

How to Manage Stormwater Problems

Participants were asked to identify their preferred solutions, and to evaluate specific actions designed to enhance urban streams or better manage problems caused by stormwater. Preferred strategies suggested in the interviews for dealing with Corvallis' stormwater problems include:

- Detain stormwater on-site; introduce new technologies that handle water on-site: sumps; detention ponds; parking lots with landscaped, pervious areas; disconnected roof drains
- Strengthen and enforce development standards; require stormwater to be detained on-site
- Natural resource protection and enhancement, including stream setback requirements and native plantings along stream banks
- Develop basin-wide stormwater plans
- Increase public education and participation in stormwater management issues

Other strategies suggested in the interviews include:

- Concentrate in the upper reaches of stream basins where problems originate
- Increase plantings and reduce impervious surface in wetland areas
- Use best management practices; "hire a lot of engineers"
- Be cost-effective
- Adopt conservation guidelines along waterways
- Study the effects of human activity on runoff
- "Daylight" urban streams now in pipes
- Build dams

Who Should Be Responsible for Stormwater Drainage?

Interview participants were also asked who should be primarily responsible to enhance urban streams and better manage stormwater drainage problems in the future.

Nearly all participants want the City of Corvallis to take the lead in addressing stormwater problems, with urban stream protection and stormwater management remaining a partnership responsibility of all parties – agencies, landowners, developers, industries, and citizens.

Stakeholders say the City's role should include planning stormwater system improvements, adopting and enforcing effective development standards, coordinating with neighboring jurisdictions ("Streams don't know political boundaries"), setting an example as a good steward of streams and watersheds, and educating and involving citizens in stormwater solutions.

Participants who suggest that leadership remain in other hands name as possible leaders: property owners, developers, Benton County or DEQ.

Effectiveness of Possible Actions to Manage Stormwater

The stakeholders interviewed were also asked about possible actions which could be very effective, somewhat effective, or not effective – to enhance urban streams or better manage problems caused by stormwater.

The following actions are rated as very effective by most participants:

- Establish trees and landscape along urban streams
- Prevent filling and development in stream floodplains
- Install ponds to detain stormwater so it enters streams more slowly
- Public education

Actions rated as effective by most participants include:

- Require better erosion and runoff control on construction sites
- Clean out sediments that restrict flows in stream channels
- Stabilize banks along streams
- Install larger culverts to allow greater stream flows to pass under roads

The only specific action rated by most participants as not effective is:

- Widen stream channels

Many of the persons interviewed caution that these actions should be implemented in an environmentally sensitive manner which preserves natural features, historic drainage patterns, and habitat. Concerns are specifically raised regarding actions to clean out sediments from stream beds, stabilize stream banks, and widen stream channels.

Other comments offered in the interviews regarding possible actions to enhance urban streams or better manage problems caused by stormwater:

- Address upstream contributions (volume and pollutants) through inter-jurisdictional dialogue and planning.
- Educate developers on stormwater management issues.
- Avoid filling remaining wetlands in Corvallis.
- Provide warnings to current and future property owners in floodplains regarding the risks of flooding.
- Build more wet weather treatment capacity to accommodate storm flows.
- Continue and improve maintenance of stormwater systems.

- Increase stream setback requirements.

IV. Public Values to Guide Decisionmaking

Participants were invited to identify key values which should guide decisions on how best to manage stormwater in Corvallis.

Values to Guide Decisionmaking

Overall, stakeholders say the primary public value to guide the Corvallis Stormwater Master Plan is to **maintain and enhance community livability**. The interview participants cite several stormwater-related factors that contribute to livability in their perception, including improving water quality, natural habitat and waterways, and protecting homes and businesses from flood damage. One community leader describes livability as "how we can best work with Mother Nature to use the existing natural landscape to manage stormwater." Another participant emphasizes the crucial condition of watersheds: "There is no life without clean water."

Other important values identified include:

- Protect the environment
- Find a long-term solution
- Protect public safety
- Protect wetlands
- Encourage public access to streams

There is also some support for several additional values:

- Improve stream habitat
- Prevent flood damage to streets and property
- Control development
- Preserve open space
- Provide educational opportunities for community
- Control erosion

Participants were also asked to rate the relative importance of several possible factors that could influence decisions about the stormwater plan for Corvallis. People were asked to rate the following factors on a scale of 1 (low) to 5 (high). A summary of the survey results is shown below:

Value	Average Score
Improve water quality	4.4
Protect public safety	4.3
Control erosion	4.1
Protect wetlands	4.0
Prevent flood damage to homes and businesses	4.0
Prevent flood damage to streets and property	3.7
Improve habitat for fish and wildlife	3.6
Control development	3.6
Retain water on-site for new development	3.6
Educate the community	3.4
Provide more open space	3.3
Ease City operations and maintenance	3.0
Encourage public access to streams	2.9
Minimize utility rates	2.2

Stream Restoration vs. Protection from Future Damage

Another issue explored in the interviews is whether improved stormwater management should place more emphasis on **restoring** streams and wetlands which have been damaged, or **protecting** streams from further damage.

Most participants say that the first priority should be to **protect** streams: "Try not to lose what you've got," in the words of one community leader. While both approaches are important, stream protection is considered as more cost-effective than restoring damaged stream corridors. There's still time, observers say, to effectively protect most streams: "There are not too many damaged streams now." And restoration is thought to be an iffy proposition: "Streams and wetlands can never be restored successfully."

How Often Should Flooding Be Tolerated?

In the interviews, participants were asked for their views on what would be an acceptable level (frequency) of flooding in the neighborhood: once every 10 years, 25 years, 50 years, or never.

Most observers are willing to accept some risk of flooding, particularly if it is on public or private property but does not damage homes. Area citizens recognize they live in a rainy climate and that some flooding is unavoidable. One stakeholder states, "Flooding will happen occasionally but it doesn't call for over-protection. You can't protect everybody all of the time."

That being said, most of the community leaders interviewed want flooding to be an infrequent occurrence: once every 10-25 years. Many others suggest a longer period of 50-100 years. Several observers want to focus on the severity of flooding, rather than frequency. In the words of one local leader: "Flooding magnitude in homes and businesses is the issue – not frequency. The key questions are: does it damage homes or businesses? Are critical services impeded?"

V. Cost

The interviews also explored the subject of cost. Is cost an important constraint in choosing the best solution? To what extent are stakeholders aware of existing stormwater drainage fees? What is the preferred method to pay for future stormwater system improvements in Corvallis? What share of the costs should be borne by existing Corvallis ratepayers – or future development?

Awareness of Current Stormwater Damage Fees

Are key stakeholders generally aware of how stormwater costs are funded in Corvallis? Do these observers know the current level of stormwater drainage utility fees?

Interview responses indicate that most community leaders don't have a clue about how much they are paying for stormwater drainage. Only a handful can correctly identify the current Corvallis stormwater charges, and most participants suspect that rates are significantly higher than today's actual monthly charges.

When asked if current stormwater drainage fees are too high – about right – or somewhat low for the services provided, most participants again say they "don't know." Other respondents are divided, citing the current fees are "too low" or "about right."

Importance of Cost Factors

Most observers say cost is an important, but not overriding, factor in reaching decisions about future stormwater system improvements. Many of the community leaders interviewed recognize improved stormwater management may cost more and the citizens will bear financial responsibility. As one stakeholder states, "Living in the big city isn't free."

Two cost-related value statements were specifically tested with participants: "Minimize utility rates" and "reduce City maintenance costs." These values are rated by most respondents as "2 or 3" on a scale of 5, or only somewhat important.

Cost-effectiveness is introduced as a theme in many interviews. Participants want to be assured that the City chooses the "right" solutions based on good technical data, but also recognize that a long-term solution needs to be cost-effective. Respondents tend to favor a solution that appears to be permanent, rather than a "quick fix."

Best Methods to Pay for Future Facilities

Participants were invited to identify their preferred funding methods to pay for future stormwater system improvements. They were also asked to comment on several specific funding options: using existing monthly rates paid by all customers; charging fees for new development; or a combination.

Virtually all observers want stormwater system improvements to be funded through a combination of monthly utility rates paid by all customers, in addition to fees paid by new development. "Everyone benefits, and everyone should contribute," one area leader summarizes.

Interview participants were also asked to what extent new development and future residents should bear the cost for improved stormwater management. Stakeholders expect new development to "pay its own way" – but not the entire cost. The City of Corvallis can use SDCs (system development charges) to collect contributions from developers. A number of observers point out that many developers are also required to construct on-site stormwater improvements at their own expense.

Several interview participants suggest a "tiered" utility or permit fee structure which charges more for developments which have more impervious surface or are located in areas contributing more stormwater to the system. These fees might be associated with elevation / slope or area of impervious surfaces.

VI. Citizen Participation

Stakeholders were also asked to contribute their suggestions on public outreach for the Corvallis Stormwater Master Plan.

Past Public Outreach Efforts

Stakeholders were queried if they have been aware of, or involved in, the City's public outreach efforts on stormwater issues. About half of the persons interviewed say they have been aware of the City's outreach, and a number of these participants have been involved themselves.

Among those who have been close observers of the City's outreach efforts, there are a few criticisms. Citizen panels have been overloaded with environmental advocates, some say, leaving out key interests such as affected property owners. Other problems cited in the interviews include limited public notice and poor citizen turnout for public meetings.

Best Methods to Communicate with Citizens

Those interviewed uniformly endorse and encourage the City of Corvallis' planned efforts to communicate with citizens regarding stormwater issues. Stakeholders observe that many citizens won't choose to become involved – but still need information. The flooding in recent years increased public awareness of stormwater issues, and has helped turn out citizens to some public meetings.

Participants were asked for their opinions on the best methods to involve area citizens more actively in community-wide stormwater planning. Observers generally support the public involvement approaches already underway or planned by the Stormwater Planning Committee and City of Corvallis. These **observers suggest that the City of Corvallis communicate with citizens on stormwater issues primarily through direct mailings, newspaper coverage and the City of Corvallis newsletter.**

Other suggested ways to get the word out could include:

- Hold public meetings
- Collaborate with watershed councils
- Develop school education programs
- City's Web page
- City Council or board meetings.

Key Groups to Target for Involvement

In the interviews, community leaders were invited to identify any key groups which should be specifically targeted to participate in Corvallis stormwater planning. Most observers suggest recruiting a cross-section of interests.

The following groups are named most often to participate in Corvallis stormwater planning:

- Benton County
- Environmental and clean water advocate groups
- Watershed councils and other citizen groups already active in planning for urban streams and stormwater
- OSU, Hewlett Packard and other large landowners
- Property owners and residents along streams
- Neighborhood associations
- Corvallis Environmental Learning Center
- Business groups: Chamber of Commerce, Corvallis Downtown Association
- Developers, homebuilders
- Flood victims
- Recreationalists and open space advocates
- Schools

Other interested groups mentioned to target for participation in stormwater planning:

- Agricultural interests
- State and Federal regulatory and resource agencies
- City staff
- Soil and water conservation groups
- Real estate brokers / associations
- Utilities
- Linn-Benton Community College
- Upstream property owners
- Garden clubs
- Senior citizens
- Citizens not represented by neighborhood or homeowners associations

VII. Other Advice

During the interviews, participants were invited to offer further advice for the Corvallis Stormwater Master Plan, and to members of the advisory Stormwater Planning Committee and the Corvallis City Council members who are ultimately responsible for reaching decisions. The following presents an overview of these final comments and suggestions offered by the persons interviewed.

Barriers to Overcome

Stakeholders were encouraged to identify the "most difficult barriers to overcome" in completing the Corvallis Stormwater Master Plan. The barriers mentioned most often are:

- Achieving community-wide consensus
- Finding solutions to accommodate planned development, while addressing a backlog of stormwater issues and maintaining natural urban waterways
- Cost vs. lack of funding; need for an affordable strategy

Other possible barriers identified by stakeholders:

- Citizen apathy
- A perception that the best thing to do with stormwater is get it off the land as soon as possible, and into the river
- Public hysteria: "People can overreact to small parts of the plan"
- Determining the appropriate level of water quality
- Gaining City Council support

Additional Participants

The stakeholders interviewed were invited to suggest other individuals or organizations to be contacted for advice at this stage of planning. The following groups were named most frequently:

- Residents of flooded neighborhoods
- Neighborhood associations
- Environmental and open space advocates: Audubon Society and others
- Developers, homebuilders
- OSU, Hewlett Packard, and other large landowners
- Corvallis Environmental Learning Center
- Recreation groups
- Business groups: Chamber of Commerce, Corvallis Downtown Association
- League of Women Voters

- Green Belt Land Trust
- State and Federal regulatory and resource agencies
- City stormwater officials
- Students

Final Advice

Participants were also invited to offer their "single most important piece of advice" to the City of Corvallis at this stage of planning to address community-wide stormwater issues. These themes are repeated by many stakeholders:

- Apply a comprehensive, basin-wide approach to stormwater management.
- Retain stormwater on-site, or as close as possible to where it falls.
- Involve and educate citizens in decisions on stormwater system improvements; "Listen really hard to what people have to say."
- Don't let flood victims, environmentalists, developers, or any other interest groups have a disproportionate say in the outcome.

Additional comments offered by one or more stakeholders:

- "Natural systems are important, too!"
- Be creative with possible solutions. Be open to new ideas and perceptions.
- Keep an eye on the need to achieve a higher level of water quality.
- If additional costs are required, show the benefits received.
- Make developers pay an equitable share (based on size of impervious surface), along with existing ratepayers.
- "Don't mess around. Hire someone who cares about protecting streams, and give them authority to do it."
- Start by establishing stormwater management practices on City property as a model.
- Do the best job you can. Don't be deterred by lack of public support.
- Get it done soon.
- "Keep everything above board and don't act like a government agency."

VIII. Appendices

Corvallis Storm Water Master Plan
Stakeholder Interviews

Neighborhood Organizations
- Jennifer Ayotte, Northeast Corvallis
- Vida Krantz, West Corvallis Association
- Karen Mayo, South Corvallis Neighborhood Association

Residents/Property Owners in Affected Areas
- Dave Livingston, Dixon Creek
- Dr. Jean Mater, Mary's River
- Doug Parker, Dixon Creek
- Ed Radke, South Corvallis

Watershed Councils
- Mary Slabaugh, Mary's River Watershed Council

Environmental/Clean Water Advocates
- Sue Danver, Friends of the Upper Willamette River
- Michele Adams, First Alternative Co-op

Corvallis Environmental Center
- Chris Beatty

Homebuilders/Developers
- Dennis Hedges, Timber Hill Corporation
- Jay Sorgen, contractor/employer

Businesses/Business Associations
- Joe Malcom, Downtown Corvallis Assn.
- Melanie Fareneuch, Chamber of Commerce

Watershed System Professionals
- Stan Gregory, OSU fisheries specialist
- Bob Metzger, USFS fish biologist

Regulatory/Resource Agencies
- Chip Andrus, U.S. Environmental Protection Agency
- Peter Idema, ODOT
- Division of State Lands

Parks and Recreation Advocates
- Meg Campbell, Green Belt Land Trust
- Rene Moye, Corvallis Parks director

Agricultural Interests
- Greg Paulson, OSU Horticulture Dept.
- Larry Venell, Venell Farms
- Tim Winn, Benton Farm Bureau

Public Schools
- Dennis Jones, District 509-J

OSU
- Kathleen Mulligan, OSU campus facilities
- Margot Pearson, Asst. Prof. Of Ag. Chemistry
- George Taylor, Climatology Dept.

Large Employers
- Steve Jasperson, Good Samaritan Hospital
- Jane Thomas, Hewlett Packard
- Ray Topping, CH2M Hill
- Brian Unwin, Evanite

Corvallis Stormwater Planning Committee
- Patricia Benner
- Mary Buckman
- Kelly Burnett
- Mary Christian *
- Gary Galovich
- Bob Grant
- Wayne Huber
- Steve King *
- Jim Minard
- Paula Minear
- Fred Wright

Other Committees and Commissions
- Patricia Daniels, Corvallis Planning Commission (DLDC staff)
- Frank DeMonte, Independent Committee for Citizen Involvement
- Mary Eichler, Benton Soil & Water Conservation District
- Jim Moorefield, Wastewater Infrastructure Committee chair

Benton County
- Jerry Davis, Planning Director
- Jim Blair, County Engineer

City of Corvallis
- Betty Griffiths, City Council
- Bruce Sorte, City Council

News Media
- Aaron Corvin (writer / environmental reporter), Gazette - Times

* Declined Interview

Corvallis Stormwater Master Plan
Stakeholder Interviews (December 1997)

NAME: ______________________________ PHONE: ________________

ORGANIZATION: ____

ADDRESS: ____

Introduction

The City of Corvallis is beginning a community-wide master plan for managing stormwater. The master plan will include community input that will be guided by a citizen planning committee. One early step is conducting interviews with community stakeholders on key stormwater issues. The committee would appreciate you contributing your views to the Corvallis Stormwater Master Plan that will be kept confidential.

1. What has been your involvement in the past regarding stormwater planning or related issues in Corvallis? If you have been aware/involved in the planning, what is your general impression?

2. Do you live near a stream?

   Yes: ___________________________________ No ____ Not sure ____
   (Which stream?)

3. With which streams in the community are you more familiar?

   ___ Willamette River   ___ Oak Creek
   ___ Dixon Creek   ___ Jackson/Frazier Creek
   ___ Mary's River   ___ Squaw Creek
   ___ Sequoia Creek   ___ Mill Race
   ___ Other: ____

4. In your view, what are the most important questions the Corvallis Stormwater Master Plan should answer?

Stormwater Issues

5. In your view, is there a problem with stormwater in Corvallis? What are a few of the top issues? (Describe)

6. Which of the following issues do you think are **very important** **somewhat important** or **not important** to address in the stormwater plan?

	Very Important	Important	Not Important	Not Sure
A. Erosion from construction sites	☐	☐	☐	☐
B. Erosion along stream banks	☐	☐	☐	☐
C. Surface pollutants entering streams	☐	☐	☐	☐
D. Loss of stream habitat	☐	☐	☐	☐
E. Flooding of streets, homes and businesses	☐	☐	☐	☐
F. Rapid runoff from new development ☐		☐	☐	☐
G. Use of streams to drain urban runoff	☐	☐	☐	☐
H. Development in floodplains	☐	☐	☐	☐
G. Other: ____________________	☐	☐	☐	☐

With which of these issues do you have the most concern?______________________

7. Are you aware of flooding in your own neighborhood? Have you experienced flooding in your own home or work place? What were the impacts? (Describe)

8. What appeared to be the origin of the flooding?

___ Clogged street gutter or catch basin

___ Stream overflowing at culvert under street

___ Stream overflowing banks

___ Flow coming out of manhole

___ Water coming out of basement drain

___ Natural occurrence of heavy rainfall

___ Upstream development

___ Inadequate development standards / or not enforced

___ Development in flood plains

___ Other: ____

___ Not sure

Possible Solutions

9. What can be done about Corvallis stormwater management issues, in your view?

10. Which of the following possible actions do you think would be **very effective** ▯ **somewhat effective** ▯ or **not effective** ▯ to enhance urban streams or better manage problems caused by stormwater in our community?

A. Require better erosion and runoff control on construction sites

___ Very effective ___ Somewhat effective ___ Not effective ___ Not sure

B. Clean out sediments that restrict flows in stream channels

___ Very effective ___ Somewhat effective ___ Not effective ___ Not sure

C. Stabilize banks along streams

___ Very effective ___ Somewhat effective ___ Not effective ___ Not sure

D. Establish trees and landscape along urban streams

___ Very effective ___ Somewhat effective ___ Not effective ___ Not sure

E. Widen stream channels

___ Very effective ___ Somewhat effective ___ Not effective ___ Not sure

F. Prevent filling and development in stream floodplains

___ Very effective ___ Somewhat effective ___ Not effective ___ Not sure

G. Install larger culverts to allow greater stream flows to pass under roads

___ Very effective ___ Somewhat effective ___ Not effective ___ Not sure

H. Install ponds to detain stormwater so it enters streams more slowly

___ Very effective ___ Somewhat effective ___ Not effective ___ Not sure

I. Public education

___ Very effective ___ Somewhat effective ___ Not effective ___ Not sure

J. Other: ____

____

11. Who should be primarily responsible to enhance urban streams or better manage stormwater drainage problems in the future?

___ City of Corvallis ___ Private citizens ___ Developers ___ All of these ___ Not sure

___ Other: ____

Public Values

12. What key values or underlying principles should guide decisions on how best to address stormwater issues?

13. How would you rate the importance of the following factors in influencing decisions for the Stormwater Master Plan? (1 low to 5 high)

A. Improve stream habitat	1	2	3	4	5
B. Prevent flood damage to streets and property	1	2	3	4	5
C. Protect public safety	1	2	3	4	5
D. Control development	1	2	3	4	5
E. Minimize utility rates	1	2	3	4	5
F. Improve water quality	1	2	3	4	5
G. Provide more open space	1	2	3	4	5
H. Provide educational opportunities for community	1	2	3	4	5
I. Control erosion	1	2	3	4	5
J. Prevent flood damage to homes and businesses	1	2	3	4	5
K. Retain water on-site from new development	1	2	3	4	5
L. Reduce City maintenance costs	1	2	3	4	5
M. Protect wetlands	1	2	3	4	5
N. Encourage public access to streams	1	2	3	4	5

14. In planning for future improved stormwater management, is it more important to **restore streams and wetlands** which have been damaged ▯ or to **protect streams and wetlands** from further damage?

___ Restore ___ Protect ___ Both ___ Not sure

15. In your view, what is an acceptable level (frequency) of flooding in Corvallis neighborhoods? Once every year ▯ 10 years ▯ 50 years ▯ never?

Cost

16. Corvallis residents and property owners currently pay for stormwater management services through a monthly utility fee for drainage that is included with the water/sewer bill. Can you recall how much your household is currently paying per month for this service?

___ Less than $1 ___ $1 to $3 ___ Over $3 to $10 ___ Over $10 ___ Not sure

17. Currently, do you feel that your stormwater drainage bills are (read list)

___ Too high, for the service provided

___ About right, for the service provided

___ Relatively low, for the service provided

___ No opinion

18. After I name three possible ways of paying for improved stormwater management, please tell me which you think is the best way for the people in Corvallis (read list).

A. Collect money exclusively through monthly utility rates paid by all customers

B. Collect money exclusively by charging fees for new development, or

C. Collect money through a combination of monthly utility rates and new development fees.

___ None of these ___ Not sure ___ Other: ____

19. Corvallis has been a growing community. To what extent should new development and future residents bear the cost for improved stormwater management? Would these charges be collected through existing fees or other methods?

Citizen Participation

20. Have you been aware of, or involved in any of the Citys citizen participation efforts on stormwater issues? How would you evaluate their effectiveness? What outreach methods have been most (or least) effective? Do you feel that all key interests or points of view have been involved?

21. Are there any key groups which should be specifically targeted to participate in Corvallis stormwater planning? Are you concerned that any of these groups will not be reached?

22. What do you suggest as the best methods to communicate with area citizens and keep them informed about stormwater issues? What can be done to ensure that interested citizens such as yourself can continue to participate in the planning process?

Wrapup

23. What do you foresee as the most difficult barrier to overcome in completing the Corvallis Stormwater Master Plan?

24. If you were responsible for solving stormwater issues in Corvallis, what would you do?

25. What is the single most important advice you would offer to the City of Corvallis at this stage regarding the Master Plan?

26. Can you suggest other individuals or any organizations we should contact now to get their advice?

27. Any final comments?

Memorandum

To: Stormwater Planning Committee

From: Business Advocacy Committee

Date: July 24, 2001

RE: Stakeholder and Public Opinion Surveys

CC: Urban Services Committee
Corvallis Public Works

Corvallis
Area Chamber
of Commerce

Among the justifications for policy recommendations in the draft Stormwater Master Plan are 'community values' demonstrated via citizen attitude surveys. It has come to our attention that the surveys in question are invalid because of poor data oversight, unexplained sampling methodology, or statistically insignificant results. The Chamber BAC recommends that all references to citizen input, community values and public opinion as supported by these surveys be removed from the SWMP.

The Stakeholder Interview Survey is fundamentally flawed for three reasons:

1. No clear definition of "stakeholder" is provided in the Executive Summary, nor was it provided upon formal request to Public Works.
2. The methodology used to determine how "stakeholder" would be defined, who would be identified as a "stakeholder," and other sampling methods are not explained in the Executive Summary, nor was this information provided upon formal request to Public Works.
3. According to Public Works, the raw data – the actual survey results – were destroyed by Barney & Worth, the research firm that compiled the data for the summary. There being no way for anyone to reexamine the results for the purposes of reinterpretation or substantiating the accuracy of the "Summary of Stakeholder Interviews," the survey itself must be considered invalid.

The telephone Public Opinion Survey results cannot be considered statistically significant because of a remarkably low response rate of under 17%. In order to be considered statistically significant, and therefore likely to generate valid results, a survey of this kind should have a minimum 70% response rate.[1] McArthur & Associates, et al attempted calls to 2,196 randomly generated phone numbers. Of those attempts, only 366 presumably resulted

---

[1] Bernard, Russell
1994 *Research Methods in Anthropology: Qualitative and Quantitative Approaches.* London: Sage Publications.

in a fully completed survey, making for a response rate of 16.7%. While some of the randomly generated calls can conceivably be factored out because they were not telephone numbers currently in service, approximately 1,674 of those numbers would have had to be out-of-service to make 366 completed surveys a potentially valid 70% response rate for a total sample of 522. It is highly unlikely that a random generation of 2,196 possible Corvallis telephone numbers generated only 522 actual Corvallis telephone numbers.

Low response rates result in serious distortions of results (response bias) and nonresponse bias is impossible to accurately measure. With high levels of nonresponse, all that can be determined is that the results are biased. At 16.7%, the results of the Public Opinion Survey are biased in the extreme and cannot under any circumstances be used to indicate Corvallis citizen attitudes. Continuing to refer to these results as substantiating a proclaimed "baseline public opinion" and "public sentiment toward the management of stormwater in Corvallis" (SWMP, 2.2) is inaccurate and misleading.

BARNEY & WORTH, INC.
1211 S.W. FIFTH AVE., SUITE 1140
PORTLAND, OREGON 97204
TEL: 503/222-0146 FAX: 503/274-7955
WEBSITE: www.barneyandworth.com

MEMORANDUM

September 5, 2001

To: Bruce Moser, Corvallis Public Works

From: Clark Worth

Re: Corvallis Stormwater Master Plan:
Response to Chamber of Commerce Correspondence

I would like to respond to key points offered in the July 24, 2001 memorandum addressed to the Stormwater Planning Committee by the Business Advocacy Committee of the Corvallis Chamber of Commerce.

Barney & Worth, Inc. participated in the early stages of the Corvallis Stormwater Master Plan, designing and implementing the public outreach program and conducting public opinion surveys.

The following responds to the questions and concerns in the Corvallis Chamber's July 24 memo.

Stakeholder Interviews

Barney & Worth interviewed about 50 key stakeholders in December 1997 – January 1998, and prepared a written summary. The list of persons to be interviewed, and questions for the interviews were selected in consultation with the Department of Public Works and the Stormwater Planning Committee. Interviews were conducted on a confidential basis, with no comments attributed to individual participants.

"Stakeholders" are generally defined as those having a "stake" – or an identifiable interest – in the outcome of a policy decision. Our attempt was to cover a broad cross-section of interested persons and organizations, including:

- Neighborhood associations
- Residents/property owners in flood prone areas
- Watershed councils
- Businesses and business associations (including the Chamber of Commerce)
- Environmental and clean water advocates
- Homebuilders/developers
- Large employers
- Agriculture representatives

- Elected officials and key staff from Corvallis and Benton County
- Regulatory/resource agencies
- Scientists and educators knowledgeable about stormwater issues
- News media
- Members of the Stormwater Planning Committee
- Other community leaders and citizens

Stakeholder interviews are not intended to provide a statistically reliable sample of Corvallis residents. Rather, they provide in-depth, *qualitative,* attitudinal data. The stakeholder interview results were not destroyed – they appear in an 18-page written report which is available to the Chamber. A list of interview participants and discussion questions accompanies the report.

Public Opinion Survey

To gather statistically reliable data on community values and opinions regarding stormwater, a public opinion survey was conducted in December 1997 – January 1998. Survey questions were developed in consultation with Corvallis Public Works and the Stormwater Planning Committee, and were pre-tested with a small number of surveys.

The public opinion research firm of McArthur & Associates supervised the telephone poll of 366 Corvallis residents age 18 and over. The sample size was established at 350, which yields a margin of error of 5 percent at the 95 percent confidence level for a target area population of 50,000.[1]

The attached material from the Survey Research Center explains *"margin of error"*, and shows how little the margin of error changes as the target population increases – once the sample size reaches about 300. A larger sample size would be useful only if needed to assure that the results remain highly reliable for sub-groups of survey respondents – for example, examine differences among the city's neighborhoods.

The actual number of completed surveys exceeded the 350 sample size somewhat due to the quota set for students. At the Stormwater Planning Committee's request, the telephone survey methodology also established a quota for Oregon State University students to match their proportion of the Corvallis population. This ensured that students would not be over- or under-represented in the results. The quota required some extra phone calls to ensure the proportionate number of students were surveyed.

The telephone survey methodology used random digit dialing, a common and reliable method for gaining a random sample of community residents. Using this methodology, many calls do not result in completed surveys, due to:

- Phone numbers not in service
- Business/office phone/fax rather than residence
- No answer/voice mail

[1] I am oversimplifying the math a little. Strictly speaking, the target population included only Corvallis residents who are 18 years or older – so considerably fewer than 50,000. This drops the margin of error below 5%.

Experience has shown that the percentage of non-residential numbers alone reaches 50% to 70% for most random digit dialed surveys.[2] The recent proliferation of fax, cell phones, pagers, etc. further exacerbates this phenomenon. The actual completion rate for the Corvallis stormwater survey was about 17%, which is deemed to be within the acceptable range of response (ordinarily 10% to 30% for this type of survey.)

While we have not reviewed the authority cited in the memorandum that establishes a minimum 70% response (Bernard Russell, 1994), we note that it is entitled "*Research Methods in Anthropology*" – not a source on public opinion research methodology.

Summary

The survey tools employed by the Corvallis Department of Public Works and the Stormwater Planning Committee – stakeholder interviews and telephone poll – are common approaches to discern public opinion on a wide range of public policy issues. Standard methodologies were used to conduct these surveys. No unusual events occurred in the survey process. As a consequence, in our professional opinion the survey results should be considered as valid.

encl.

[2] See Paul Lavrakas, *Telephone Survey Methods*, Northwestern University, 1992.

Survey
Research
Center

Calculate a Sample

Valid Sample Size

The margin of error is a measure that determines the representativeness of a sample by comparing the number of respondents in the sample to the number of people in the population. The opinions expressed by respondents in a sample are an *estimate* of the opinions held by all people within the target population. The opinions expressed in a sample are estimates because the only way to truly measure the opinions of the whole population would be to interview each individual in the population. Generally, as sample size increases the margin of error decreases. Therefore, as the sample size increases, the opinions measured in the sample will be closer to those within the actual population.

Through accepted mathematical formulas, confidence level and margin of error are calculated. For example, a margin of error of +4.9 percent at the 95 percent confidence level means that if 40 percent of the respondents answer "yes" to a question, we can be 95 percent confident that the actual value in the population to this question is 4.9 percentage points higher or lower than 40 percent. In other words, the actual range falls between 35.1 percent and 44.9 percent. This range is referred to as the "confidence interval." Some other examples at the 95 percent confidence level are presented below:

Target Population	Sample Size	Margin of Error	Proportion of Population
100,000	800	$\pm$ 3.5	0.8%
100,000	500	$\pm$ 4.4	0.5%
1,000	400	$\pm$ 3.8	40%

1,000	300	$\pm$ 4.7	30%
800	300	$\pm$ 4.5	38%
800	200	$\pm$ 6.0	25%
500	300	$\pm$ 3.6	60%
500	200	$\pm$ 5.4	40%

95 percent confidence level

This level of confidence requires a sample size large enough that if the same survey were conducted 100 times with a random sample, only five of the surveys would be expected to yield results outside the margin of error.

Home Mission Services Staff Methodologies Guest Book Links

Evaluation Criteria for the Development of an Updated Corvallis Stormwater Master Plan

March 1, 1999

The following stormwater evaluation criteria have been developed by the Stormwater Planning Committee. These criteria are based on community values and objectives gathered through random telephone and stakeholder surveys, and input from citizens at several public meetings. Revisions to the draft evaluation criteria were made after collecting comments during the December, 1998 public meeting.

The evaluation criteria will be used by the Stormwater Planning Committee, other citizen participants, consultants and staff as the guide in developing and evaluating strategies and alternatives for the Stormwater Master Plan within the framework of the community's values. The criteria text also identifies a number of common stormwater issues that will be helpful background and discussion information .

The next step in the Stormwater process is to examine each of the city's stream basins. Please look for public meeting times for this basin work. The first meeting for Dixon and Squaw Creek basins will be March 30, 1999 at the City/County Public Library on Monroe. We would like to hank you for your involvement in this process,

What Is in the Boxes??

1. A stormwater evaluation criterion (♦) in large letters is found at the top of the box. These criteria were developed by the Stormwater Planning Committee based on community values and objectives. Though each criterion and its text is presented within its individual box, all of the criteria are interwoven and related to the others.

2. **Questions (•) help to identify the intent and components of the evaluation criterion. The bullets may not be inclusive of all criterion elements, but they provide a framework for discussion and evaluation.**

3. *Information that might help illustrate a concept.*

Evaluation Criteria

based on Community Values
for the Corvallis Stormwater Master Planning Process

March 1, 1999

- Maintains and Accommodates Natural Hydrological Processes
- Protects and Improves Water Quality
- Controls Unwanted Erosion
- Protects and Restores Natural Resources and Ecosystem Functions
- Meets or Exceeds Current Regulations and Anticipated Future Regulations
- Cost Considerations are Inclusive
- Addresses Maintenance Requirements and Allows for Maintenance Access
- Incorporates Community Awareness and Information Exchange
- Addresses Cumulative Impacts and Off-site Impacts
- Is Designed and Managed to Avoid Public Health and Safety Hazards
- Incorporates Community Amenities
- Explores and Utilizes Innovative and Low-technology Approaches
- Implements Urban and Rural Land Use Objectives

Stormwater Master Planning Developing strategies to address issues such as water quality, flood damage, erosion and stream health.

Evaluation Criteria
based on Community Values
for the Corvallis Stormwater Master Planning Process

March 1, 1999

♦ Maintains and Accommodates Natural Hydrological Processes

- **Is there protection or restoration, anticipation of, and allowance for natural disturbance events and outcomes such as flooding and stream bank erosion?**

Information: Water's natural movement, both above and below ground, are generally beneficial to stream and other water-dominated systems and their associated resources. In addition, natural hydrological processes such as flooding are often expensive or nearly impossible to control or prevent.

- **Is ground infiltration, detention, seasonal stream flow patterns, and other natural water movement maintained?**

Information: What is "natural?" Webster's II New Riverside University Dictionary (1988) defines "natural" as, " Conforming to the usual or ordinary course of nature." Preserving natural hydrology in an urban setting is probably not possible. However, many landscape hydrological functions and processes can often be maintained or reestablished.

- **Is mitigation a requirement for stormwater discharges?**

Information: Urbanization without mitigating design features can alter the location and movement of stormwater (both above and below-ground) and decrease the land's ability to detain and manage stormwater. Pavement, hillside terracing, loss of vegetation that intercepts and then re-evaporates rain, and wetland and stream channel changes are among the urban features that can increase the amount and speed of stormwater run-off, and increase the number and size of floods. Careful urban design can reduce these changes and impacts.

♦ Protects and Improves Water Quality

- **Is the contamination of surface and ground water by pollutants prevented?**

<u>Information</u>: *Contaminants that are found on streets and parking lots can contribute to stream, wetland, and ground water quality degradation. These pollutants are currently piped along with stormwater runoff to nearby streams. Lawn fertilizers, herbicides and pet waste can also pollute water. Increased stream flows can contribute to abnormal erosion and increased water turbidity.*

- **Are seasonal water temperatures protected or improved?**

<u>Information</u>: *Summer water temperatures usually increase when a stream channel is not shaded.*

- **Are landscape features such as wetlands and floodplains recognized for their ability to filter and process pollutants?**

♦ Controls Unwanted Erosion

- **Is natural erosion accommodated where possible?**
- **Is erosion that results from urbanization and its consequences minimized?**

<u>Information</u>: *Natural erosion is important for stream health and is a common ecological process. And, if a section of stream bank is protected from erosion, often the erosive energy of the water will only be transferred to another location. Additional human-caused bank erosion can occur, for example, when urbanization increases stream flows or bank vegetation is removed. Erosion can also occur at construction sites, and sediment can then enter city pipes and streams, increasing water turbidity.*

♦ Protects and Restores Natural Resources and Ecosystem Functions

- **Is there protection of existing wetlands, stream systems, and other significant natural features such as swales?**

Information: Protection can deal with different issues. Maintaining a watercourse's hydrology to prevent abnormal erosion or provide summer stream flows is one example; setting aside a natural feature would be another form of protection. Some human-made features such as relocated stream channels might be considered to now provide functional habitat.

- **Is there protection and enhancement of native fish communities?**

Information: State regulations currently require protection of native fish populations, including fish passage past culverts, a common urban issue.

- **Is there protection and enhancement of stream corridors and floodplains, riparian communities, and their ecological functions?**

- **Is there protection and enhancement of native vegetation and wildlife habitat?**

- **Does reclamation/restoration improve natural ecological functions and processes as well repair damaged natural features?**

Information: Sustainable restoration of an ecosystem requires reestablishing the ecological "operations" of that system. That includes both the functions of the system such as providing fish habitat, and the processes such as nutrient exchange between the riparian corridor and stream channel.

- **Does the plan utilize resource protection as a management approach as an alternative to focusing on restoration as a management tool?**

Information: Resource managers and communities often choose projects that restore degraded parts of an ecosystem rather than protection of existing non-degraded areas. Yet it is often less expensive to protect rather than restore a system.

♦ Meets or Exceeds Current Regulations and Anticipated Future Regulations

- **Are current Federal and State regulations that presently apply to the City addressed and implemented?**

- **Are regulations that are anticipated within the foreseeable future and the life of the stormwater plan dealt with?**

Information: Current regulations are the rules that presently apply to the City according to state or federal laws. An anticipated regulation is one in the foreseeable future of the life of the plan. Anticipated regulations include, for example, regulations that are only applied when a community reaches a certain population size (Clean Water Act.) Another type of anticipated regulation is one that is likely to be enacted as a response to a problem or issue. The listing of Willamette River winter steelhead as a threatened or endangered species is a possible example (Endangered Species Act.)

♦ Cost Considerations are Inclusive

- **Is there equitable cost allocation based on what generates the cost?**

- **Is cost analysis based on all costs, both direct (traditional economic) and indirect (ecological and social), immediate and long-term, and does it incorporate the other community stormwater evaluation criteria?**

Information: Examples of direct costs are project-related expenditures such as materials and labor to put in a culvert or the cost of setting aside land for stormwater detention. Indirect costs might include impacts on a fisheries, flooding of homes downstream, water pollution, or ongoing maintenance costs. And, benefits can be both direct and indirect.

- **Are costs reasonable in relation to the products and results, and does cost analysis include elements such as economies of scale and project timing efficiency?**

♦ Addresses Maintenance Requirements and Allows for Maintenance Access

- **Are maintenance requirements supported by existing community resources?**

- **Is maintenance access sufficient to allow for the sustainable management of the stormwater system to implement the community's values, multiple functions of those systems?**

Information: Homes and other buildings constructed immediately abutting stormwater infrastructure such as a detention basin or wetland could block maintenance access. And, structures built abutting a stream channel may create the need for a larger and ongoing maintenance efforts for that watercourse to protect those structures.

- **Are upper basin activities that affect downstream conditions, including the cumulative impacts of urbanization, considered with respect to their potential impact on downstream maintenance requirements?**

- **Are maintenance approaches selected in the context of other community stormwater values and objectives?**

♦ Incorporates Community Awareness and Information Exchange

- **Are community educational opportunities incorporated into the development and implementation of the Plan?**

- **Does the design and siting of projects contribute to public knowledge and awareness?**

Information: Several schools are near a stream or wetland, and students use these systems as places to learn. Citizen surveys have shown a strong interest in the community being given the opportunity to be informed about stormwater-related topics. Stormwater restoration and other projects provide informational opportunities.

♦ Addresses Cumulative Impacts and Off-site Impacts

- **Is the cumulative effect of urbanization estimated and addressed within the plan and at the time of each future development?**

Explanation: For some urban-related impacts, evaluation is done only at the site level and not in context of multiple urban activities. Stormwater-type examples are filling within a floodplain, or grading of land that reduces water detention.

- **Are upstream and downstream negative impacts, and off-site and on-site negative impacts minimized?**

- **Are quantitative correlations and goals made to address cumulative impacts on offsite locations?**

Explanation: Negative water-related and other impacts can extend beyond the boundaries of an urbanized piece of property. Examples include increased downstream flooding, erosion or sedimentation, blocking fish passage, or a reduction in summer surface stream flows.

♦ Is Designed and Managed to Avoid Public Health and Safety Hazards

- **Are community health and safety hazards related to stormwater addressed?**

- **Is the risk of flood damage to buildings minimized?**

- **Is the risk of damage to urban infrastructure such as streets and bridges minimized?**

Information: Natural flooding is difficult to completely control, and engineered flood-control structures are often expensive and sometimes fallible. Stormwater management strategies and development standards can reduce the magnitude of increased urban runoff and significantly lessen the risk of damage from natural flooding.

♦ Incorporates Community Amenities

- **Can recreational opportunities be provided?**
- **Is there protection of open space?**

Information: Stormwater infrastructure can be multi-objective in function if supported by the community, including conserving urban space and improving community livability. However, recreational activities can cause significant damage to natural systems if not located and managed carefully.

- **Are available City plans for trails, open space and parks incorporated into the stormwater planning process?**
- **Are the inherent values of natural features in urban areas being recognized?**

Information: Urban natural features such as waterways can enhance the aesthetic and economic value of public and private lands.

♦ Explores and Utilizes Innovative and Low-technology Approaches

- **Are innovative and low-technology approaches examined and used when applicable?**

Information: Selection of technology involves a number of considerations, including short and long-term direct and indirect costs, maintenance, possibilities for amenities, and density transfer to maintain urban densities.

- **Are present stormwater management methods evaluated to determine whether they are appropriate or effective?**

Information: A recent stormwater practice has been to dispose of street runoff into streams and to put small creeks into underground pipes. In the past urban runoff was piped along with sewage to a plant to be treated for contaminants.

♦ Implements Urban and Rural Land Use Objectives

- **Are significant resource lands within and outside of the urban growth boundary protected?**

- **Are urban lands efficiently developed to urban densities and other urban standards?**

- **Can redevelopment and infill opportunities be provided for in the Stormwater Master Plan and stormwater development standards?**

- **Are innovative development standards (such as density transfer) used to implement these urban and rural land use standards?**

Information: Urban land use patterns that optimize the use of city lands for urban-type development protect resource lands outside of the current urban growth boundary. An example is that compact urban development postpones or prevents the expansion of the urban growth boundary onto farm and forest lands. Conversely, protection of significant resources within urban areas is also a concern for many citizens, and can be a part of the infrastructure that manages urban runoff. However, protection of natural features can contribute to "urban sprawl" if not balanced with adequate urban density." Both objectives listed above are reflected in the Corvallis Comprehensive Plan policies.

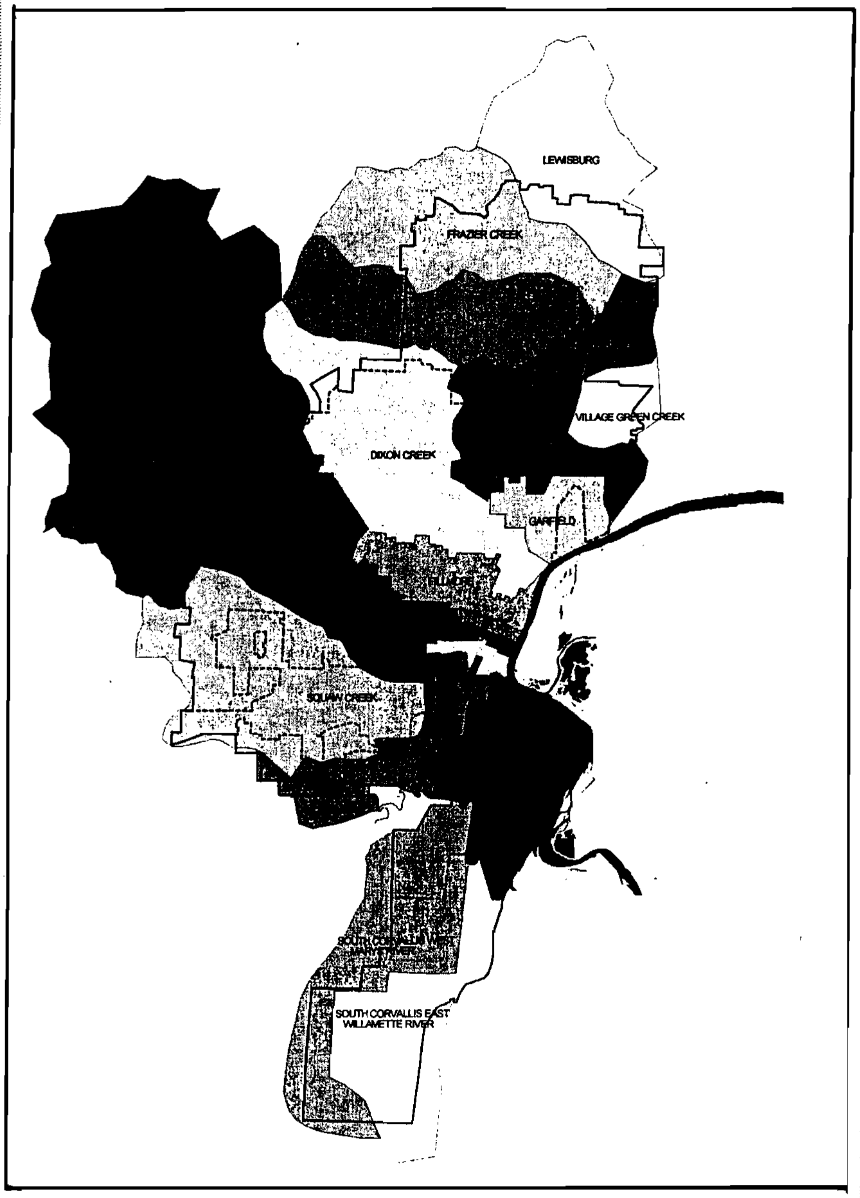
- **Is land available to reserve and use for stormwater management, and what ownership status would adequately protect the land for future stormwater uses?**

Information: For example, it can be difficult for a community to find and acquire a suitable site for a new school or fire station. Communities have sometimes set aside land prior to urban growth to prepare for future schools, parks or other urban requirements. Not all urban community needs are necessarily provided for through public ownership, however.

Stormwater Alternatives Public Workshops

March 16 and repeated on April 1, 2000

Citizen Input Workbook and Information Packet



Map of Corvallis Stream Basins

Sponsored by the City of Corvallis Public Works Department and the Stormwater Planning Committee
For more information, call 766-6916

Evaluation Criteria

based on Community Values
for the Corvallis Stormwater Master Planning Process

March 1, 1999

- Maintains and Accommodates Natural Hydrological Processes
- Protects and Improves Water Quality
- Controls Unwanted Erosion
- Protects and Restores Natural Resources and Ecosystem Functions
- Meets or Exceeds Current Regulations and Anticipated Future Regulations
- Cost Considerations are Inclusive
- Addresses Maintenance Requirements and Allows for Maintenance Access
- Incorporates Community Awareness and Information Exchange
- Addresses Cumulative Impacts and Off-site Impacts
- Is Designed and Managed to Avoid Public Health and Safety Hazards
- Incorporates Community Amenities
- Explores and Utilizes Innovative and Low-technology Approaches
- Implements Urban and Rural Land Use Objectives

Stormwater Master Planning

Developing strategies to address issues such as water quality, flood damage, erosion and stream health.

Evaluation Criteria
for the Corvallis Stormwater Master Planning Process
Developed from Community Input

Please rate each ♦ evaluation criterion in terms of your view of its level of importance or your level of support in stormwater planning and management. Rate 0 (lowest) to 5 (high). For this exercise, the ● descriptions in the boxes should help frame and describe each criterion.

♦ Maintains and Accommodates Natural Hydrological Processes

Evaluation Criteria:

- Is there protection or restoration, anticipation of, and allowance for natural disturbance events and outcomes such as flooding and stream bank erosion?
- Is ground infiltration, detention, seasonal stream flow patterns, and other natural water movement maintained?
- Is mitigation a requirement for storm water discharges?

♦ Protects and Improves Water Quality

- Is the contamination of surface and ground water by pollutants prevented?
- Are seasonal water temperatures protected or improved?
- Are landscape features such as wetlands and floodplains recognized for their ability to filter and process pallutants?

♦ Controls Unwanted Erosion

- Is natural erosion accommodated where possible?
- Is erosion that results from urbanization and its consequences minimized?

♦ Protects and Restores Natural Resources and Ecosystem Functions

- Is there protection of existing wetlands, stream systems, and other significant natural features such as swales?
- Is there protection and enhancement of native fish communities?
- Is there protection and enhancement of stream corridors and floodplains, riparian communities, and their ecological functions?
- Is there protection and enhancement of native vegetation and wildlife habitat?
- Does reclamation/restoration improve natural ecological functions and processes as well repair damaged natural features?

♦ Meets or Exceeds Current Regulations and Anticipated Future Regulations

- Are current Federal and State regulations that presently apply to the City addressed and implemented?
- Are regulations that are anticipated within the foreseeable future and the life of the storm water plan dealt with?

♦ Cost Considerations are Inclusive

- Is there equitable cost allocation based on what generates the cost?
- Is cost analysis based on all costs, both direct (traditional economic) and indirect (ecological and social), immediate and long-term, and does it incorporate the other community stormwater evaluation criteria?
- Are costs reasonable in relation to the products and results, and does cost analysis include elements such as economies of scale and project timing efficiency?

♦ **Addresses Maintenance Requirements and Allows for Maintenance Access**

- Are maintenance requirements supported by existing community resources?
- Is maintenance access sufficient to allow for the sustainable management of the stormwater system to implement the community's values, multiple functions of those systems?
- Are upper basin activities that affect downstream conditions, including the cumulative impacts of urbanization, considered with respect to their potential impact on downstream maintenance requirements?
- Are maintenance approaches selected in the context of other community stormwater values and objectives?

♦ **Incorporates Community Awareness and Information Exchange**

- Are community educational opportunities incorporated into the development and implementation of the Plan?
- Does the design and siting of projects contribute to public knowledge and awareness?

♦ **Addresses Cumulative Impacts and Off-site Impacts**

- Is the cumulative effect of urbanization estimated and addressed within the plan and at the time of each future development?
- Are upstream and downstream negative impacts, and off-site and on-site negative impacts minimized?
- Are quantitative correlations and goals made to address cumulative impacts on offsite locations?

♦ **Is Designed and Managed to Avoid Public Health and Safety Hazards**

- Are community health and safety hazards related to stormwater addressed?
- Is the risk of flood damage to buildings minimized?
- Is the risk of damage to urban infrastructure such as streets and bridges minimized?

♦ **Incorporates Community Amenities**

- Can recreational opportunities be provided?
- Is there protection of open space?
- Are available City plans for trails, open space and parks incorporated into the storm water planning process?
- Are the inherent values of natural features in urban areas being recognized?

♦ **Explores and Utilizes Innovative and Low-technology Approaches**

- Are innovative and low-technology approaches examined and used when applicable?
- Are present stormwater management methods evaluated to determine whether they are appropriate or effective?

♦ **Implements Urban and Rural Land Use Objectives**

- Are significant resource lands within and outside of the urban growth boundary protected?
- Are urban lands efficiently developed to urban densities and other urban standards?
- Can redevelopment and infill opportunities be provided for in the Stormwater Master Plan and stormwater development standards?
- Are innovative development standards (such as density transfer) used to implement these urban and rural land use standards?
- Is land available to reserve and use for stormwater management, and what ownership status would adequately protect the land for future storm water uses?

Comments: ______________________________

____

The Watershed

What development standards, land use practices, and protection should we propose for outside of the stream corridor and floodplain?

I. The Watershed: Water Quality and Water Detention

Background Information

Rain water falls within a basin, and gradually travels to a stream. The way in which we use land outside of the stream corridor and floodplain affects the quality of water, the rate of flow into urban streams. It also generally reduces the amount that returns to the groundwater. Impervious surfaces prevent stormwater from soaking into the soil, increasing runoff rates and reducing water quality. Streets, especially, create shortcuts for water to reach the stream. Recontouring the land and removal of vegetation also reduce the watershed's ability to detain and manage water. Other urban practices contribute pollutants and degrade water quality.

Solutions can be structural and non-structural. We can consider development standards that guide new construction towards methods that maintain water flow and quality. Additionally, we can consider programs that modify homeowner activities, such as pesticide use or vehicle cleaning and maintenance, to minimize the pollutants added to water flowing into streams. Protection and restoration of landscape features such as key wetlands are also important tools for water quality.

Some standards exist to guide development to protect water flow and quality. The *Corvallis Comprehensive Plan* adopted policies in 1998 that limit peak stream flows to the level that existed prior to development and protect water quality. Other standards provide for percentage of landscaped surfaces on developed property.

Common Residential Urban Stormwater Pollutants

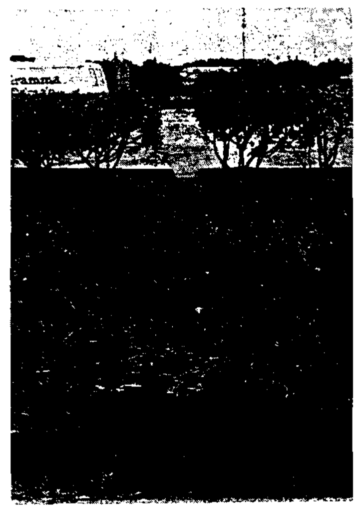
Pollutants (median concentrations)	Oregon Land use[a]	Nationwide[b]
Total suspended solids	43.2 mg/liter	101.0 mg/liter
Biological oxygen demand	5.8 mg/liter	10.0 mg/liter
Carbon oxygen demand	33.4 mg/liter	73.0 mg/liter
Total phosphorous	0.15 mg/liter	0.38 mg/liter
Dissolved phosphorus	0.03 mg/liter	0.14 mg/liter
Nitrate and nitrite	0.37 mg/liter	-------
Total copper	0.010 mg/liter	0.033 mg/liter
Total lead	0.010 mg/liter	0.144 mg/liter
Total zinc	0.069 mg/liter	0.135 mg/liter

[a] Oregon data from Eugene, Gresham, Portland, Salem, Bell Station, Lake Oswego, Milwaulkie, Oregon City, and Tualatin area (USA).
[b] Nationwide Urban Runoff Program

The Combined Sewer Overflow

Another water quality issue in Corvallis is known as the Combined Sewer Overflow (CSO) Project. The sewer system for the older part of town collects rainfall runoff and sewage from homes and businesses into one pipe that goes to the sewage treatment plant. A heavy rainfall can overload the sewer system, causing a mix of rainwater and raw sewage to overflow the pipe system and discharge to the Willamette River.

Though this is also a stormwater issue, it is being dealt with separately. A $32 million CSO Project is being constructed to address overflows from up to a 5-year rainfall event. Stormwater will receive primary-type water quality treatment from these improvements. This project will be completed this year (2000).



What is the City's Current Approach to Water Quality?

The City of Corvallis population recently reached 50,000, and cities of this size are required to meet additional federal stormwater regulations for water quality.

The City has management practices to improve runoff water quality. For example, the City regularly sweeps streets to collect debris and its associated contaminants from the roadways before they can be picked up by stormwater runoff. It also has an information outreach program that includes storm drain labeling and informational fliers (please see City stormwater program handout for additional information).

At this time, debris and larger sediment is removed from water that enters city street storm drains (catchment basins). Many commercial and industrial developments remove oil and debris from stormwater before discharging it into a creek, river, or the City's storm system. However, some older parking lots in the City drain directly to a creek without any form of water quality treatment.

What is the City's Current Approach to Stormwater Detention?

The purpose of detention is to delay the movement of water from a development because of impervious surfaces (concrete driveways, streets) to a stream or wetland to simulate pre-development peak runoff levels. The City now requests that new developments include detention facilities, but detention standards have not been formalized into Corvallis' *Land Development Code*. The *Corvallis Land Development Code* text gives specific guidelines for development.

Though detention is typically designed to manage the runoff from a development so that stream's peak flow is the same as before the development (for up to a 10-year storm event), the overall hydrology of a stream is often still changed after development.

Additional References for Water Quality and Detention

Please refer to attacments for information on these topics.

- *Corvallis Comprehensive Plan* policies that directly relate to water quality and detention.
- A sampling of *Benton County Comprehensive Plan* policies relating to basin-wide stormwater resources.
- Pending Federal Regulatians that affect stormwater planning summary.

Additional Reference Material

- ✓ Portland Metro Water Quality & Floodplain Protection, called Title 3 website: http://www.multinomah.lib.or.us/metro/growth/tfplan/funcplan.html
- ✓ Phase II Stormwater Rules website: http://www.epa.gov/owm/sw/phase2
- ✓ American Forests website for information on urban forests, interception, etc: http://www.americanforests.org

Water Quality and Water Detention Alternatives

Watershed Water Quality and Detention	Strongly support (SS), support (S), neutral (N), oppose (O), strongly oppose (SO), or unsure (?)* *If unsure, what information might help you decide? Please Write Comments Here, too
A. General Water Quality Alternatives	
Construction-related strategies: a range from local government practices, information outreach and incentives vs. to regulation/requiring.	
A1. Public Practices - develop public infrastructure to provide for best management of stormwater quality and quantity (such as parking lots with pervious surfaces and public buildings that use innovative methods to clean stormwater), and implement "Best Management Practices" *(these are activities like construction erosion control and sweeping the streets to pick up contaminants).* Comments: government practices can be a model for community; . Narrow street can impact emergency response	
A2. Inform the public and encourage use of building techniques that maintain water quality and flow rates, such as roof gutters that don't drain into the street, pervious or narrow driveways, and green space on lots. Comments: A voluntary approach to stormwater management.	
A3. Provide incentives for private construction that promotes use of building techniques that maintain water quality and flow rates, such as disconnected gutters, pervious or narrow driveways and required green space on lots. Comments: Examples include stormwater-innovative houses such as ones with disconnected gutters may have reduced stormwater monthly fees;	
A4. Mandate standards for all new construction that use building techniques that maintain water quality and flow rates, such as disconnected gutters, pervious or narrow driveways and required green space on lots. Comments: Uniform expectations for each development; infrastructure can be expensive; connect environmental costs with sources.	
Human Activity-related strategies: a range from local government practices, information outreach and incentives vs. to regulation/requiring.	
A6. The City to go beyond minimal Best Management Practices mandated by the federal government for this sized city for runoff water quality (ongoing activities like construction erosion control and additional street cleaning). Comments: Government practices can be a model for community; requires additional public funds from sources like increased utility rates..	
A7. Inform the public about Best Management Practices for maintaining water quality such as washing the car on the lawn, picking up dog feces, reduction of automobile use, vegetation management, and reduced use of pesticides and fertilizers. Comments: Voluntary approach to stormwater management; everyday practices of individuals and businesses are to a great extent self-managed.	
A8. Provide incentives and public/private partnerships for using best management practices for maintaining water quality. Comments: Example: work with service clubs and organizations for information outreach.	
A9. Mandate and enforce best management practices for maintaining water quality. Comments: City staff to monitor private maintenance of stormwater-treating infrastructure and construction sites; will require increased stormwater rates.	
Other activity-related strategies?	

B. Specific Water Quality and Detention Alternatives	
B1. Is it appropriate to require property owners to manage stormwater in a manner that it does not affect neighboring properties?	
B2. Should incentives be provided for the protection of sensitive areas such as wetlands and riparian areas on private property for water quality and natural detention?	
B3. Should the City perform additional monitoring of stream water quality pollutant indicators to determine if we are achieving water quality expectations? Comments: The City currently monitors for temperature, pH, dissolved oxygen, and bacterial contamination; additional monitoring would require additional funding.	
B4. Should the City monitor biological indicators of stream health such as fish or aquatic insect populations? Comments: would require additional funding	
B5. Should the City identify and acquire significant wetlands and other significant areas for water quality and natural detention? And, if so, how is it funded?	☐ Storm water fees on utility bill ☐ City bonds ☐ Property taxes ☐ Building permit for redevelopment in urbanized areas ☐ Other____________________
B6. Should the City do more to protect upland vegetation to maintain vegetation's stormwater function in the watershed? Comments: City land use policy currently protects "significant native plant communities" and significant hillside trees.	
B7. Should City development standards require parking structures for developments that require larger parking facilities?	
B8. Should the City establish, or encourage the formation of a local wetland bank for same-basin wetland mitigation?	
B9. Should streets and/or parking lots function as temporary storage areas for larger, infrequent floods if it doesn't compromise public safety? Comment: a less expensive way to manage larger flood events than in pipes or other flood water storage infrastructure; re-routing of traffic & travel inconveniences; street cleaning after a flood.	If so, for how long should street or parking lot be flooded?
B10. Should the City develop a local program of guidelines and enforcement for stormwater objectives to either reinforce or be a substitute for state regulations Comments: implementation of state wetland regulations by state agencies, but with local guidance for protection and restoration; construction erosion control, etc). An example - standard state construction site sediment control methods aren't always site-functional.	Please give types of stormwater-related procedures and guidelines where this could work/or might not work.

C. Retrofitting City Infrastructure to Treat Runoff in Developed Parts of the City	
C1. As a general approach to stormwater disposal, is it appropriate to pipe untreated stormwater runoff into streams? Comment: Most parts of town send piped runoff to the stream with minimal treatment.	
Alternative C2. Continue or increase existing City practices such as street cleaning; continue to discharge stormwater runoff to local streams; City implement no additional infrastructure and practices (street storm drain catchment basins trap larger sediment and debris). Continue/increase pollution prevention public education and outreach.	
Alternative C3. Retrofit City-owned street catchment basins (storm drains) with water treatment devices to collect pollutants. Comment: Retrofitting infrastructure to improve water quality is expensive, so it is worth determining if the community would like to explore this option further as a possibility.	If you support this alternative, which way(s) could you support it being funded? ☐ Storm water fees on utility bill ☐ City bonds ☐ Property taxes ☐ Building permit for redevelopment in urbanized areas ☐ Other____________________
Other Approaches and Alternatives?	

II. Stormwater-related Community Involvement

Background Information

City staff are often called upon to work with the community in some stormwater capacity, especially with streams. Some recent examples are the Dixon Creek Corvallis High School project, an OSU graduate project at the Community Outreach site on Dixon Creek, flood mitigation in the area of Lancaster, and the riparian restoration work on Dixon Creek at Circle and Kings Boulevards. Staff are asked to give presentations at schools, and receive telephone calls from citizen groups looking for volunteer projects or activities that are often related to stormwater issues.

D. Community Involvement Alternatives	Strongly support (SS), support (S), neutral (N), oppose (O), strongly oppose (SO), or unsure (?)* *If unsure, what information might help you decide? Please Write Comments Here, too
Assuming that there must be some management of urban streams to meet Federal and State regulations, and local codes, how should individual property owners (residential, commercial, etc) be helped to comply with stormwater standards?	
Alternative D1. <u>Individual citizens</u>: citizens/property owners take personal responsibility for preventing and minimizing pollution at the source.	
Alternative D2. <u>Private, voluntary organizations only</u>: independently trained; no relationship with City government for support. e.g the Corvallis Environmental Center, service clubs or neighborhood Stream Watch groups.	
Alternative D3. <u>Private-Public partnerships</u>: Volunteers from the community or volunteer organizations, with some City staff support and/or under staff supervision (training, equipment, project ideas, etc); would call for additional staff.	
Alternative D4. <u>Public only</u>: A new City department or a new branch of an existing department with enough staff for the tasks, funded by stormwater utility fees.	
Other(s):	
D4. Should the community provide opportunities for developer sponsored, publically managed demonstration systems - (restoration, water quality treatment, fish culvert passage, etc.)	
Other(s): Have we missed an option? Please give us your comments.	

III. Jurisdictional Boundaries and Stormwater Management

Background Information

Citizen comments, beginning early in this stormwater public meeting process, made it clear that addressing stormwater issues at a watershed scale was a significant issue for many participants. However, this means finding ways in which to work outside the city limits.

There are three political/land use areas that would be affected by this approach: the city proper, the urban fringe scheduled for urban development bounded by the Urban Growth Boundary (UGB), and the land outside of the urban growth boundary. The last two are under the County's jurisdiction. However, the City and County have together created guidelines for the urban fringe to meet special objectives. (Please also note that Oregon's Land Use Planning Program allows for expansion of the urban fringe by moving the UGB, so this resource land is not absolutely protected from future urbanization.)

Additional Information

- *Benton County and Corvallis Comprehensive Plans policy* excerpts.
- Citizen comments summary

Stormwater Jurisdictional Management Alternatives

E. Stormwater Jurisdictional Management Alternatives	Strongly support (SS), support (S), neutral (N), oppose (DS), strongly oppose (SO)), or unsure (?)* *If unsure, what information might help you decide? Please Write Comments Here, too
Alternative E1. City reviews and comments on County plans and development applications (this is what is currently done to some extent.) Property owners can receive guidance from state & federal agency local offices.	
Alternative E2. Develop a City-County agreement for storm water management in the Corvallis urban fringe portion of the urban growth boundary (UGB) area.	
Alternative E3. Identify County *Comprehensive Plan* policies that propose County action that would contribute to storm water management, ond work with the County to implement these policies, including for watershed lands beyond the UGB area (see attachment for specific policies).	
Alternative E4. A watershed-wide education outreach to increase awareness regarding storm water management issues.	
Alternative E5. Annex, upon a majority public vote, all urban growth boundary (UGB) land promptly so that City land use policies and standards apply.	
Other:	

Multiple-Use of Urban Lands

Multiple objectives for the use of urban lands conserves urban area, and in turn protects resource lands outside of the city.

For example, several parks manage floodwater since they are in a floodplain. Several include wetlands that temporarily detain stormwater to reduce natural flooding. The special development policies that protect the tree-covered hillside views are also providing for stormwater management in the watershed. The trees intercept rainfall, and reduce slope erosion.

Being aware of this option and practice may increase the opportunity for urban strategies like these.

The Floodplain

To what extent should there be development in a 100-year floodplain?

I. Floodplain Functions and Issues

Floodplain strategies for managing stream basin water can be based on a number of objectives. Some of these objectives are reducing the risk of damage to buildings or preventing human injury, storing flood waters, or protecting fisheries resources.

Functions:

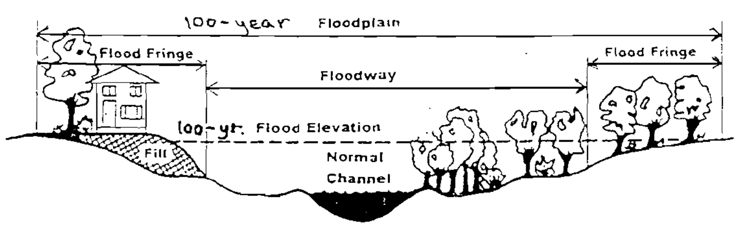
- Transports flood waters; is an extension of the channel.
- Is a temporary storage of flood water.
- Is significant habitat for fish, including a refuge area during a flood, and high value feeding zone when flooded.
- Collects sediment that is being transported in the floodwater; sediment settles out of the water onto the floodplain and so stays in the basin.
- Reduces flood water velocity that cause erosion by allowing the water to spread out.
- Location for recharging groundwater.

Issues:

- Potential damage to structures and risk to life.
- Isolation from emergency services, etc during a flood.
- Other(s)?____

  ____

Stream Corridor Section Showing the 100-year Floodplain and Floodway



<u>**What makes up the 100-year floodplain**</u>? The 100-year floodplain is divided into two zones, the floodway and floodway fringe. Development is allowed in the floodway fringe, and fairly restricted in the floodway for most structures. Table 1 describes these zones and a 100-year floodplain.

Table 1.

Floodplains. For FEMA regulatory purposes, a floodplain is divided into two areas:
Floodway -   <u>A general description</u>: The portion of the floodplain, typically the channel and the land adjacent to the channel, that is kept generally unobstructed to allow for water flow. It is where the bulk of the flood water is transported downstream and where the water velocities and flood forces are generally the greatest.   <u>A technical definition</u>: The stream channel or other watercourse and the adjacent land areas that must be reserved in order to accommodate and transport a 100-year flood without cumulatively increasing the water surface elevation more than 0.2 ft, as the rest of the floodplain is developed.
Floodway fringe - is the area outside of the floodway.   It is calculated to be the portion of the floodplain that could be completely filled without raising the 100-year flood by more than 0.2 ft. at any point. In its natural state, the floodway fringe stores flood waters, and has a water current that is generally slow or slack.
100-year flood - a flood that has a 1% chance of occurring each year.   **100-year floodplain** - spans the entire area of land that can be flooded during an average 100-year period. It includes the range of land that floods *annually* to the highest ground that has only a 1% chance of flooding each year.

II. The Current City Standards for Floodplain Development and General Floodplain Information

<u>Floodplain Development Guidelines</u>. Corvallis floodplain development standards generally follow the Federal Emergency Management Agency's (FEMA) Insurance Program.

Development, including fill, is currently allowed in Corvallis within the 100-year floodplain outside of the floodway (see Table 2 for a more complete explanation).

Table 2.

Current Development Standards for Floodplains
Floodway development. New construction, substantial improvements, and other encroachments are generally prohibited in the 0.2 floodway. *Non-structural* development, such as parking lots, is permitted if it does not result in any increase in flood levels and/or flood hazards.
Floodway fringe development. (Land that is within the 100-year floodplain but outside of the floodway.) ***Residential*** structures and substantial improvements must have the lowest floor, including a basement, elevated to a minimum of 1 ft above the 100-year flood-water elevation. (Can be built either on fill or elevated so that water can flow under the house or apartment.) ***Non-residential*** structures and substantial improvements must have the lowest floor, including a basement, elevated to a minimum of 1 ft above the 100-year flood-water elevation, ***or*** be flood-proofed and capable of resisting flood-water forces.

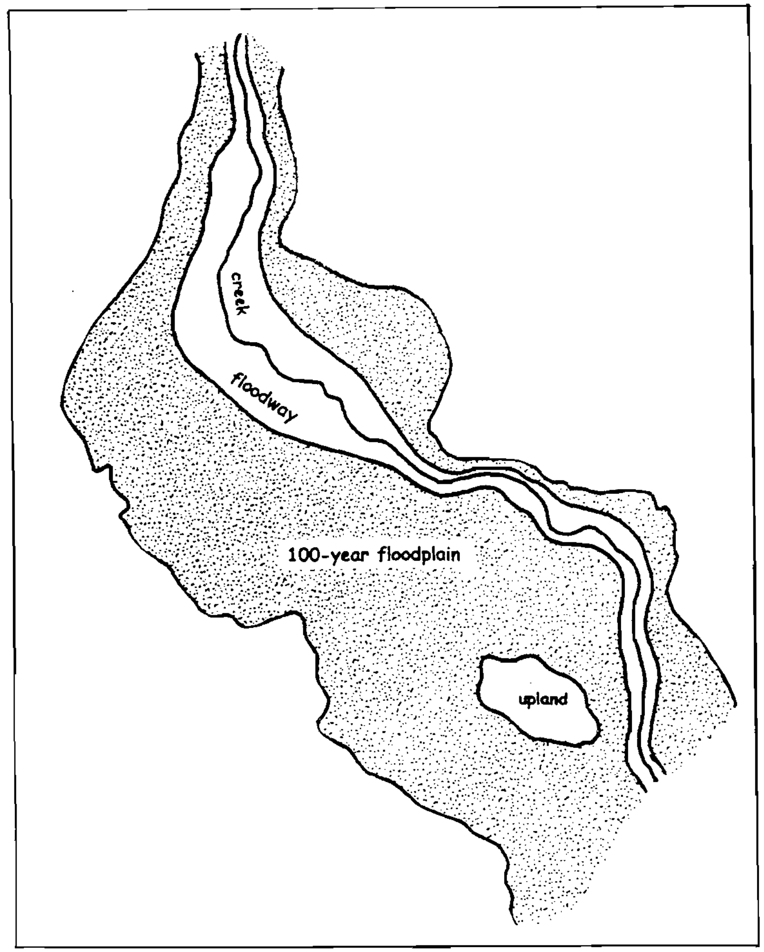
III. Additional Background Information

Please refer to attachments for information on these topics.

- *Corvallis Comprehensive Plan* (adopted 1998) policies related to floodplain development.
- Citizen comments at previous public meetings and surveys.

<u>Additional Reference Material</u>:

- ✓ FEMA (Federal Emergency Management Agency website: http://www.fema.gov
- ✓ Portland Metro Water Quality & Floodplain Protection, called Title 3 website: **http://www.multinomah.lib.or.us/metro/growth/tfplan/fumcplan.html**



An Example of a Floodplain and Floodway along a Creek.

The 100-year floodplain and the floodway can vary greatly in width, depending on the topography, how deeply the channel is ditched (channel incision), and the amount of water that comes from the watershed.

IV. FLOODPLAIN DEVELOPMENT ALTERNATIVES.

With the Stormwater Evaluation Criteria in mind, which alternative(s) do you support?
Please use: strongly support (SS), support (S), neutral (N), oppose (O), strongly oppose (SP), or unsure (?)*.

100-Year Floodplain Development Alternatives For new development or substantial improvements, and with no structural development in floodway* * See Table 1 for floodway & floodplain explanations (Note: the 100-year floodplain includes lands that are flooded each year)	**With the Storm Water Evaluation Criteria in Mind, which Alternative(s) Do You Support? Please use strongly support (SS), support (S), neutral (N), oppose (O), strongly oppose (SO), or unsure (?)** (If you don't know, what information might help?)	
	Streams **(Dixon, Squaw, Oak, Jackson, Frazier, Sequoia, & Ryan Creeks; Village Green/Stewart Slough)**	**Mary's River and Mill Race**
Alternative A1. Keep existing development standards. May build in the 100- year floodplain outside of the floodway, if elevated (on fill or without restricting flow), or flood-proofed (see Table 2). Comments: Filling, etc removes floodwater storage capacity, and can either cause flow velocities to increase (also possibly altering erosive forces), or transfer floodwaters to other areas. Slow-water portions of the floodplain are refuge and feeding areas for fish. However, urban areas may be where trade-offs are made with priorities towards development.		
Alternative A2. No net fill in the 100-year floodplain outside of the floodway. Allows development, but filling must be offset with excavation at site to maintain flood water capacity (a balanced cut & fill). Comments: Allows development, while floodplain storage area is not lost; but in small creek systems, could sometimes alter how the water moves downstream, effecting erosion and deposition patterns.		
Alternative A3. Allow construction in the 100-year floodplain outside of the floodway, but structures must be elevated so as to not restrict flow - i.e. without fill or other water-displacing design. Comments: Would minimize hydrological impacts to the water course; lattice, or other visual barrier could visually improve structure, or open parking could be under building; may be difficult to prevent owners from walling space in at later date.		
Alternative A4. No structural development within the 100-year floodplain. Can use density transfer to offset floodplain development constraints for residential areas. Comments: Separates building land use from the hydrological function of the floodplain;. Minimizes potential conflicts between flooding and urban land uses; some loss of land available for urban development. Density trnasfer is a residential development option, where if some land is set aside as open space to protect a significant resource, than that development can build houses at a higher density.		
Other:		

How Much Land is in Corvallis is in the Mapped 100-year Floodplain?

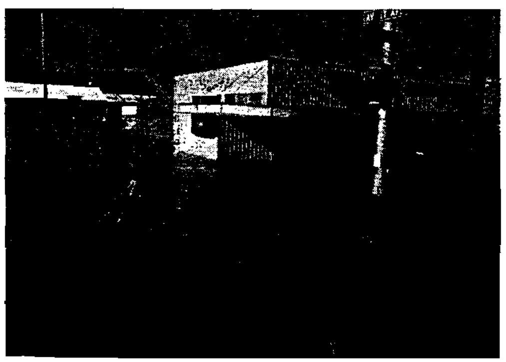
The are approximately 900 acres of land in the FEMA-mapped 100-year floodplain within the urban growth boundary area that are zoned for urban development.* However, about ***one-third*** of this floodplain land is in the floodway, the area where most construction is prohibited.

The floodplain in most parts of town is already largely developed. However, the Jackson-Frazier basins have not been annexed and developed at urban levels.

There are approximately 120 acres of mapped 100-year floodplain in the urban growth boundary area in the Jackson-Frazier basins. However, **over 60%** of this floodplain is in the floodway, and is generally structurally undevelopable.

The remaining floodplain land in the urban growth boundary area (approximately another 900 acres) is in open space.

* Based on Federal Emergency Management Agency (FEMA) mapping.



South 3rd Street during the February, 1996 flood.

V. FLOODPLAIN SUPPLEMENTAL QUESTIONS: With the Stormwater Evaluation Criteria in mind, which alternative(s) do you support? Please use, strongly support (SS), support (S), neutral (N), oppose (O), strongly oppose (SO), or unsure (?)*. *If unsure, what information might help you decide?

Additional Floodplain Management Questions	Strongly support (SS), support (S), neutral (N), oppose (O), strongly oppose (SO), or unsure (?)* *If unsure, what information might help you decide?	Comments
FLOODPLAIN PROTECTION AND RESTORATION:		
B. Provide incentives for floodplain restoration and protection as a part of a development process. **Possible benefits include**: Provides other approaches to floodplain protection other than regulatory during the development process. May have more options for floodplain management. **Possible costs include**: Would require a more complex development review process.		
C. Create ongoing floodplain protection and restoration opportunities for private and public entities that are independent of development processes. **Possible benefits include**: Don't have to rely on a development process to enhance and protect floodplain functions. **Possible costs include**: contributing to urban sprawl that moves into forest & farm resource lands; local government must find funding source(s).		
Other(s) & Additional Comments:		

V. FLOODPLAIN SUPPLEMENTAL QUESTIONS (cont'd.): With the Stormwater Evaluation Criteria in mind, which alternative(s) do you support? Please use, strongly support (SS), support (S), neutral (N), oppose (O), strongly oppose (SO), or unsure (?)*. *If unsure, what information might help you decide?

Additional Floodplain Management Questions	Strongly support (SS), support (S), neutral (N), oppose (O), strongly oppose (SO), or unsure (?)* *If unsure, what information might help you decide?	Comments
D. Would you support the purchase of buildings and land in the floodplain from willing sellers to put into open space or other more compatible use? **Possible benefits include:** eliminating repeated property damage risk; lessening conflicts between natural flooding & urban land uses; improve flood water transport & fisheries restoration; reducing FEMA insurance rates. **Possible costs include:** contributing to urban sprawl that moves into forest & farm resource lands; local government must find funding source(s).	Floodway? Floodway fringe? (the land in the 100-year floodplain outside of the floodway	**Which Ways Could You Support Purchases Being Funded?** ❑ Additional storm water fees on utility bill ❑ FEMA (Federal Emergency Management Agency) Funds ❑ Open space or other bond money ❑ Other
*What information might help you decide? & Others/ Comments:		
E. Do you think that the land outside of the 100-year floodplain, but in the 101 to 500-year floodplain should be subject to any floodplain-related development guidelines? **Possible benefits include:** the planning for larger flood events to reduce risk and damage. **Possible costs include:** setting aside urban land into open space or more costly development guidelines for flood events that are fairly rare.		
*What information might help you decide?		
F. Should yards in new residential development be located within the 100-year floodplain of local streams, as a general practice? **Possible benefits include:** Floodplain is incorporated into developments without risk to structures. **Possible costs include:** Conflicts arise between residential activities like landscaping or filling and periodic flooding.	Floodway? Floodway fringe?	
*What information might help you decide? & Comments		

Marys River in flood stage at Brooklane, 1996.

Stream Corridor Widths

What do you suggest for the management of lands along watercourses?

I. Stream Corridor Functions and Issues

The stream corridor is a key part of a stream system. The stream corridor plays many roles for the health of a stream system and the management of urban impacts on stream resources.

One way of determining how much land to protect along a stream channel is to identify a stream corridor's primary functions, including those created by the urban environment, and then estimate the width based on these functional objectives. This streamside land can be called the ***functional corridor***. This functional corridor will vary in width depending on the variability of each stream and stream section. It will also vary in Corvallis depending on to what extent the community wishes to protect these functions,

Functions

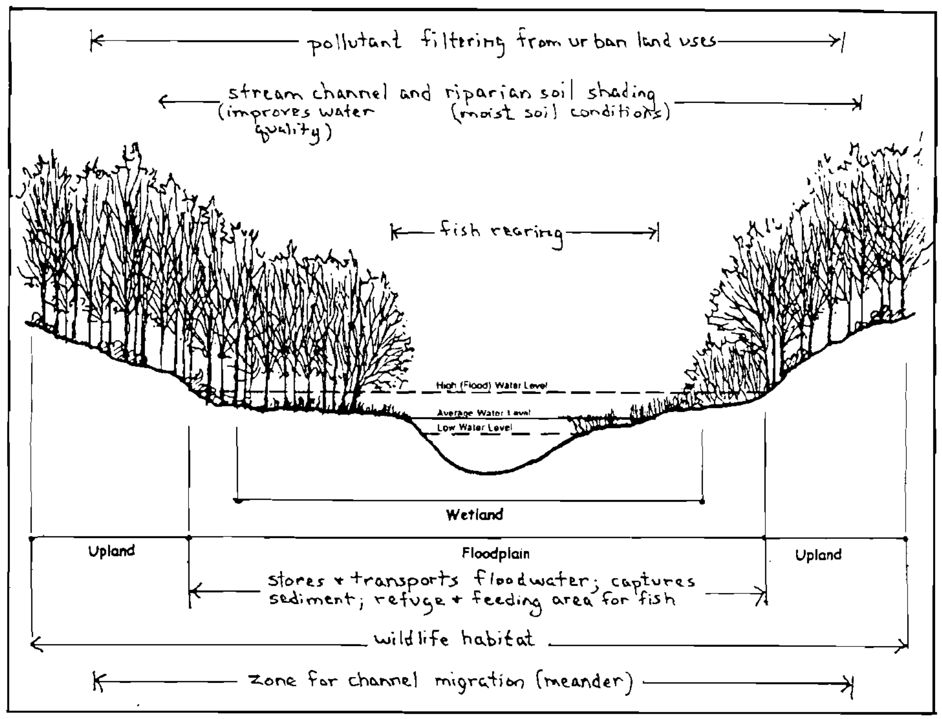
- ✳ Improve and protect water quality, including shading stream waters, trapping sediments, and filtering pollutants.
- ✳ Allow for natural channel movement and bank erosion; setbacks to minimize the chances of having to stabilize stream banks, sustain natural stability with vegetation.
- ✳ Accommodate natural floods and protect floodplains, while reducing the risk of property damage from flooding through land use alternatives.
- ✳ Protect wetlands adjacent to the stream channel.
- ✳ Protect or reestablish biological resources associated with the stream channel and corridor such fish populations and trees.
- ✳ Reduce drainageway maintenance costs with a system that is self-functioning.
- ✳ Minimize conflicts between the functions of abutting land uses

Issues

- ✳ Address possible costs of land to developers and/or the community.
- ✳ Address the issue that setting aside open space in urban areas can create losses of rural resource lands through expansion of the Urban Growth Boundary, if compensating measures are not taken.
- ✳ Address federal endangered species proposed rules for salmon and steelhead, and Phase II storm water quality rules.
- ✳ Other(s)?

____

An Approximation of Some Functional Zones within a Stream Corridor



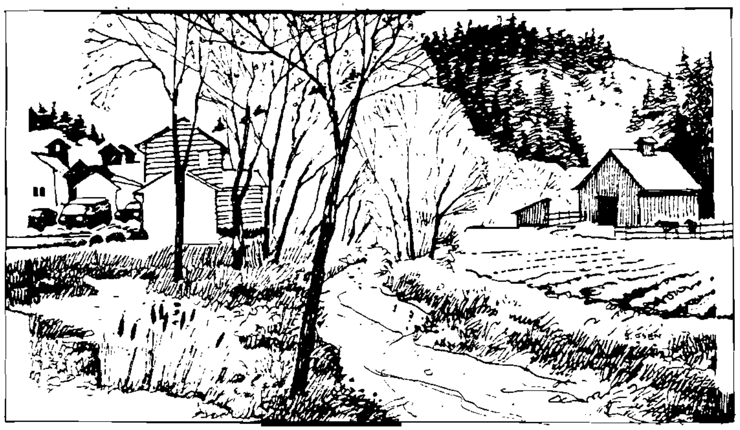
The corridor of land adjacent to a stream channel serves a number of functions. For example, within this stream corridor there is a zone for filtering pollutants in runoff, a zone to store flood waters, a meander zone for the stream channel natural movement, a zone for channel shade cover and leaf food source for stream organisms, and a habitat corridor for wildlife.

II. Current City Practice for Determining Stream Corridor Widths

When a segment of stream (that serves a drainageway function) is on a piece of urban land that is being developed, the stream and its corridor are dedicated (deeded) to the City. A formula that is based on the variables listed below determines the width of this stream corridor. In the older part of town, many individual property lines go to the center of the stream channel. In these areas easements might be obtained by the City to complete projects, such as flood mitigation.

- stream channel width (up to 30 ft)
- bank steepness (steeper = a wider corridor)
- floodway width (floodway is the portion of the floodplain reserved [kept free of obstructions] to transport flood waters; and where high volumes of moving water flow)
- floodplain width (up to 50 feet on each side of the channel)

(See attached informational sheet for details on the establishment of the dedicated stream corridor width)



Past land practices have placed urban and rural land uses immediately adjacent to the stream channel. This often created conflicts between the various uses.
drawing by Bruce Osen

Table 1. Stream Corridor Dedicated or Easement Widths on each side of the stream channel (based on the current *Corvallis Land Development Code* [1993] standards).

Channel Width from top of bank	* Current dedicated width *on each side of the stream channel* for:	
	a channel with sloping bank	a channel with steep, high bank
5 ft. wide	7 - 12 ft	12 - 17 ft
10 ft. wide	15 - 20 ft	24 - 29 ft
15 ft. wide	22 - 27 ft	36 - 41 ft
20 ft. wide	30 -35 ft	48 - 53 ft
25 ft. wide	37 - 42 ft	60 - 65 ft
30 ft. wide +	45 - 50 ft	72 - 77 ft
any width channel	to include the entire floodway in the locations where greater than formula	
using the LDC riparian definition	Include all of the natural riparian vegetation	

* Exception: 5 ft. of the stream corridor dedication can be waived when the City Engineer finds that there is a minimal risk that impervious cover, compaction, or trenching activities will occur in the 5 ft area." That is why there is a 5 ft range of widths in these two columns.

* Exception: If the 100-year floodplain extends beyond these widths, additional width shall be provided for flood management. "Such dedications shall not exceed 50 ft as measured from the top of the bank."

III. For Additional Background Information

Please refer to attachments for information on these topics.

- *Corvallis Comprehensive Plan* policies that directly relate to stream corridor widths
- Citizen comments from public meetings
- Stream Corridor Width Dedication Calculation from the *Land Development Code*
- New federal and state regulations summary for stormwater and threatened salmonids

<u>Additional Reference Material</u>:

- ✓ For information on the threatened spring chinook salmon and winter steelhead listings proposed rules: http://www.nwr.noaa.gov
- ✓ For information on stream corridors and wetlands: http://www.epa/owow
- ✓ For information on Oregon's land use goals, including natural resources and flood hazard planning statutes: http://www.lcd.state.or.us
- ✓ For background information on FEMA: http://www.fema.gov

Stream Corridor Maintenance Effort

Narrow stream corridor widths create the potential for increased maintenance efforts and costs. Wider stream corridors generally reduce the amount of surveillance and maintenance work required. (City maintenance is usually funded by a monthly stormwater utility fee.)

For example, if there is bank erosion, bank stabilization work would be needed if a building were close to the channel.

Or, if a tree falls down in a narrow stream corridor and diverts flow, in a wider corridor it could be left to provide habitat for fish, but in a narrow corridor the tree would probably have to be removed to prevent flooding, bank erosion or other impacts on adjacent land uses.

Willamette Salmonid Listing under the Endangered Species Act

The Federal government National Marine Fisheries Service (NMFS) has proposed the draft "4(d) Rules" for the protection of the recently listed chinook salmon and steelhead in the upper Willamette Basin under the Endangered Species Act. Because of the salmonids' threatened status, it is possible that Corvallis will need modify its stream corridor strategy to contribute to the conserving of the fish populations.

IV. STREAM CORRIDOR WIDTH ALTERNATIVES: With the Stormwater Evaluation Criteria in mind, which alternative(s) do you support? Please use: strongly support (SS), support (S), neutral (N), oppose (O), strongly oppose (SO), or unsure (?)*. ***Note: A method for stream width implementation such as a formula might need to be developed as an option, since site studies are expensive.***

Alternatives for Stream Corridor Width on each Side of the Channel for New Development and Redevelopment (to extent possible with land ownership patterns and existing permitted structures) These alternatives would be for the local perennial and intermittent creeks; Marys River & Willamette to be addressed separately. Please see other alternatives section for connected issues, like how to fund.	Strongly support (SS), support (S), neutral (N), oppose (O), strongly oppose (SO) or unsure (??)*	Comments, and *If unsure, what information might help you decide? (Please use back of paper, too)
A1. EXISTING: Maintain existing standards of 7 ft to 77 ft on each side of the channel, depending on stream channel width (or floodway width, or riparian vegetation width, if greater). [From a 5 ft wide channel to a 30 ft or wider channel.] Advantages: *Estimate of Functions Provided*: Provides minor to fair stream corridor function protection, depending on the channel, the location, and width. Minimizes loss of urban land for development. Disadvantages: Especially for smaller streams, may not meet physical and biological objectives in stormwater evaluation criteria; potential for conflicts with abutting land uses.		
A2. UP to 100 FEET: Variable stream corridor widths to address stream corridor functions, with a minimum width on each side of stream of 50 feet, and up to a maximum width of 100 feet on each side of the channel, (or floodway width, or riparian vegetation width, if greater). Advantages: *Estimate of Functions Provided*: Provides for stream shading, with partial pollutant filtering; depending on channel characteristics and floodplain size, accommodates some bank erosion and channel movement, maintenance cost reduction, partially protects stream habitat complexity and natural resources; protects some or all adjacent wetland, includes a substantial portion of the 100-year floodplain (hydrological function); flexible width to adapt to different stream segments; protects what is typically the most sensitive part of the stream corridor. The protection level of a function can vary based on other variables like soil type and surrounding topography. Disadvantages: Possible increased land and development costs; minor urban sprawl potential if there are not offsetting measures like density transfer where significant resource land is protected in trade for higher density residential development; may fall short of addressing salmonid threatened species rules in some locations; parcel might be undevelopable unless exempted.		
A3. UP to 150 FEET: Variable stream corridor widths to address stream corridor functions, with a minimum width on each side of stream of 50 feet, and up to a maximum width of 150 feet on each side of the channel, (or floodway width, or riparian vegetation width, if greater). Advantages: *Estimate of Functions Provided* Provides for stream corridor functions to a greater degree than alternative A2 for pollutant filtering, reducing maintenance and bank stabilization needs, allowing for channel movement, riparian vegetation and natural resource protection, and hydrological function; would include much or all of the 100-year floodplain and wetland along most stream segments; probably minimize the risk of a threatened salmonid "take" if properly applied. Disadvantages: Possible increased land and development costs; urban sprawl potential as in alternate "A2." possible need for a public funding source..		
A4. UP to 200 FEET: Variable stream corridor widths to address stream corridor functions, with a minimum width on each side of stream of 50 feet, and up to a maximum width of 200 feet on each side of the channel, (or floodway width, or riparian vegetation width, if greater). Advantages: *Estimate of Functions Provided*: Under most circumstances would meet stream corridor functional objectives and contain most functional zones, with the possible exception of hydrological (floodplain) in a few areas. Would probably eliminate the risk of a "take" for the listed salmonids if properly applied: is a flexible width to adapt to different stream segments; Creates space for restoration of natural channel characteristics, if altered; Maximizes large wood inputs to riparian area and channel. Provides for virtually all stream corridor functions except for hydrological (floodplain) in a few areas. The protection level of a function can vary based on other variables. Disadvantages: Similar increased land and development costs as A3; urban sprawl potential as in alternate "A3"; probable need for a public funding source.		
A5. Standard Set Widths of 50, 100 and 200 FEET: Set stream corridor width on each side of the channel, with each stream divided into three segments, upstream, midstream and lower; with the inner 50 ft most protected, (or floodway width, or riparian vegetation width, if greater). Advantages: *Estimate of functions provided*: Easier to implement because of set widths, would hopefully capture a significant percentage of corridor functions addressed in A2 - A4. Disadvantages: Is not adaptable to variable-width functional zones.. Others similar to alternatives A2-A4.		
Other(s)? Please use space on back of sheet, too.		

V. <u>STREAM CORRIDOR SUPPLEMENTAL QUESTIONS</u>: **With the Stormwater Evaluation Criteria in Mind, which Alternative(s) do You Support? Please use: strongly support (SS), support (S), neutral (N), oppose (O), strongly oppose (SO), or unsure (??)*.**

Additional Stream Corridor Alternatives and Associated Questions Please rate each idea or alternative independently	**Strongly support (SS), support (S), neutral (N), oppose (O), strongly oppose (SO), or unsure (??)*** ***If unsure, what information might help you decide?** **Please Write Comments Here, too**		
General Question: Does your home or business property border a stream ? (Circle one) Yes No			
B. Additional Stream Corridor Width Questions			
B1. **Floodplain:** Should the stream corridor width be wide enough to include the entire 100-year floodplain where the floodplain goes beyond your preferred width?			
B2. **Minimum Width:** Should the stream corridor **minimum** width on each side of a channel be different than 50 feet? If so, how much?	(Circle one) Yes No	Greater than 50 ft How much?	Fewer than 50 ft How much?
C. Stream Corridor Protection, Enhancement and Restoration			
C1. The City should provide incentives for stream corridor restoration as a part of the urban development process.			
C2. The City should create ongoing stream corridor protection and restoration opportunities for private and public entities that are separate from development processes, on both publicly and privately-owned lands.			
C3. The City should create a land use ordinance and management guidelines for riparian communities along streams.			
C4. The City should develop a program for information outreach to citizens and provide support to streamside residents and others for stream and corridor protection, enhancement and restoration work.			
Other?			
D. Ownership of Stream Corridors			
D1. Should stream functional corridors be placed in public or private ownership at the time of urban development (please rate each one)?	City-owned	Privately owned	Ownership should vary, depending on situation
D2. Should either a conservation easement or acquiring a stream functional corridor outright be the preferred method for City stream corridor acquisition (please rate each one)?	Acquire land	Acquire conservation easements, land remains in private ownership	A mix of both acquisition & conservation easements
Other? Additional Comments:			

Additional Stream Corridor Alternatives and Associated Questions (cont'd.) Please rate each idea or alternative independently	Strongly support (SS), support (S), neutral (N), oppose (O), strongly oppose (SO), or unsure (??)* *If unsure, what information might help you decide? Please Write Comments Here, too
E. How to Fund the Acquisition of Stream Corridor Land or Conservation Easements, if Acquired by City?	
Alternative E1. Existing approach - where land is dedicated to City by the development where the stream flows.	
Alternative E2. Shared acquisition costs between development and the community,	
Alternative E3. A Systems Development Charge where all new development contributes financially towards stream corridor acquisition as part of the urban stormwater infrastructure.	
Alternative E4. Shared acquisition costs between a systems development charge and the community.	
Alternative E5. In the absence of a development proposal, purchased entirely through public funds (stormwater utility fees, FEMA funds, bond money	
Other?	

F. If your answer to Alternatives D2, D4, and/or D5 (above) was positive, how should the City fund these purchases (check every one that you think is appropriate)?	
☐ Storm water fees on utility bill ☐ FEMA (Federal Emergency Management Agency) Funds ☐ Open space or other bond money ☐ property taxes ☐ Other ☐ Unsure	
G. Swales: Should swales, smaller unchannelized watercourses with seasonally flowing water (subsurface a greater part of the year), be protected in some manner for stormwater functions? Example: Timberhill multiple swales in wooded area downslope of Arrowood Circle adjacent to bike path.	

H. Water Treatment Siting. Is it suitable to site runoff treatment infrastructure like constructed bioswales adjacent to the stream functional corridor?	

I. Recreational Access. Should public ***recreational access*** such as bike paths be placed within stream corridors to encourage recreational use? (Community comments include the feeling of intrusion into private areas, possible impacts on stream, to an urban passive recreational amenity.)	

J. Natural Vegetated Corridors. Should fallen trees be left and native vegetation be permitted to grow within stream corridors, for naturally functioning stream systems?	

STORMWATER MASTER PLAN
CITIZEN INPUT FROM WORKBOOK & INFORMATION PACKET
MARCH 16, 2000 and APRIL 1, 2000

32 Exercises Turned in To-Date

5/2/00

EVALUATION CRITERIA	Ratings Total (0 = low, 5 = high)						Comments
	0	1	2	3	4	5	
1. Maintains & Accommodates Natural Hydrological Process				2	5	22	
2. Protects & Improves Water Quality				3	5	19	
3. Controls Unwanted Erosion				1	8	18	P20 - (circled unwanted and natural) Hard to identify.
4. Protects & Restores Natural Resources & Ecosystem Functions		1		2	2	22	P7 - This is the most important criterion.
5. Meets or Exceeds Current Regulations & Anticipated Future Regulations	1		2	3	5	16	
6. Cost Considerations are Inclusive			2	5	6	14	
7. Addresses Maintenance Requirements & Allows for Maintenance Access				6	9	13	P7 - ? P9 - second line item - future options? P20 - (circled supported) Possible with
8. Incorporates Community Awareness & Information Exchange			2	8	8	9	P20 - Not needed on all projects.
9. Address Cumulative Impacts & Off-Site Impacts				1	2	23	P7 - ? P20 - If the issues of page 3 have been addressed, many cumulative impacts will already be addressed.
10. Is Designed & Managed to Avoid Public Health & Safety Hazards	1	1		3	11	11	P9 - second line item - addressed, move the building? P9 -third line item - redesign considered?
11. Incorporates Community Amenities		1	5	3	5	12	P20 - Very important on some projects - not applicable to others. P21 - These don't seem to fit. Natural free stream systems are the amenity.
12. Explores & Utilizes Innovative & Low-Technology Approaches		1	2	4	7	14	P20 - At times, high tech may be the preferable approach and should be explored and utilized.
13. Implements Urban & Rural Land Use Objectives				5	9	12	P7 - (circled bullets 1 & 2) Are these compatible goals?

Comments	P5 - All important issues! P6 - All of these criteria are very important. I think it is important to look at all of these aspects-many times only a few criteria are satisfied while the rest aren't even addressed. The Plan should be as holistic as possible. P9 - Diversity in uses increases options for funding, i.e. trails (commuting paths) in conjunction with green way stream corridors, increase chances of funding (ICT). P10 - All are important in the planning process. Hard to rank other than 5. P14 - Far too many of these criteria are focused on ecosystems, maintaining wetlands. The focus of the Plan ought to be on erosion control, property protection, flood control. P15 - Some of the bullets are very different from each other - I would want different numbers by different bullets within each (diamond, i.e. criteria). Why not set this exercise up so we can rate all of the ideas? For example, open space and natural features are <u>not</u> equal to recreation. P17 - Is it important that the Stormwater Master Plan address these criteria? (added at the end of the criteria list another bullet titled:) Need for improved connectivity not serious compromising water quality, etc., etc. Our table was struggling to understand just what we were rating. P18 - Is it important that the Stormwater Master Plan address these issues? P20 - It seems to me that the Stormwater Master Plan is a subject of land use objectives. No activity should happen unless it is compatible with those separate requirements. P22 - Good ideas for formulating action without objections. P24 - This could have been designed to fit on much less paper which also would have reduced mailing costs. These are great questions! I'm impressed we're <u>finally</u> asking ourselves these types of questions. Does this plan protect natural ecosystem functions? Whoa! There's a good question. P25 - I believe the City should inspect channels more frequently. Look for dams and debris. P27 - A very impressive piece of work. Thanks you all for taking this on. P28 - I found it difficult not to use all 5's. I realize that sort of defeats the purpose - but all of these seem important and defendable. P31 - Where conflicts between water quality, riparian function, etc. and recreational use occur, recreational use is secondary.

WATERSHED WATER QUALITY ALTERNATIVES

General Water Quality Alternatives (page 3)	Total Ratings (SS = strongly support, S = support, N = Neutral, O = oppose SO = Strongly Oppose, ? = Unsure)						Comments
	SS	S	N	O	SO	?	
A1 - Public Practices	16	11	2				P7 - do "Best Management Practices" change with new research and information? They should. P9- parking lot redesign-infiltration, maintain ground water and "clean water quality P20 - Set example. P30 - But consider if pervious surface parking lots are better than collection and treatment. Public facilities need to set an example. P31 - Government should be held to the same standard as private interests (and vice-versa). This said, Corvallis acting as a model, I believe, is a low yield activity. LDC or Building Code serves all parties.

General Water Quality Alternatives (page 3) cont'd.	Total Ratings (SS = strongly support, S = support, N = Neutral, O = oppose SO = Strongly Oppose, ? = Unsure)						Comments:
	SS	S	N	O	SO	?	
A2 - Inform the public and encourage use...	17	8	3	1		1	P20 - Educate. P23 - If roof gutters are directed to drain fields, this can create worse problems for individual home owners - flooding of neighbors, crawl space problems, etc. P30 - An interesting challenge. Especially when it comes to local building standards such as driveway requirements. Pervious surface could slow stream rates but (depending on what happens on your driveway) it may contribute to lower quality of ground water and soil. P31 - Although coaching and encouraging are exemplary, a legal framework is required to produce results. P32 - Especially for already developed areas.
A3 - Provide incentives	13	12	2	3			P12 - incentives for required green space? P20 - Entice. P23 - See A2. P26 - Must apply to rental property in meaningful way. P30 - Good. Provide clear guidelines. How do you deal with footing drains? P31 - See comments above.
A4 - Mandate standards	17	5	3	4	1		P9- for some people this is the only way they will comply P20 - Require. P23 - See A2 for examples of potential unexpected consequences of mandated techniques. P24 - I would love to mandate standards but developers have to come to these truths on their own. They have to see the beauty and value of protecting natural systems - mandating only makes their hearts harder. P28 - Work toward this as public becomes more educated. Maybe mandate standards in 5 or 10 years. P31 - Obviously, I think this direction produces the required results. P32 - The worst offenders probably won't do it unless required!
A6 (Note no A5) - City to go beyond minimal best management practices	17	4	5	2		1	P23 - Federal rules appear to be very weak on a drainage basin and area basis. P30 - City needs to set example. Recent CSO work has been pretty good.
A7 - Inform the public about best management practices	20	8	2				P7 - oppose voluntary only activities. P23 - Also encourage use of drop spreaders rather than rotary spreaders when applying pesticides/herbicides/fertilizers. Perhaps ban rotary spreaders. P30 - The best way to solve the non point source pollution issue is through public education. (vs. centralized systems are usually very expensive.)
A8 - Provide incentives and public / private partnerships	17	6	6				P6 - like Eugene "Stream Team". P19 - Love the idea of adopt a stream. P23 - Several schools have classes working on related issues. Encourage more science teachers (both OSU and 509J) to pick related topics and provide them with necessary support. P32 - Especially for residential already developed.

General Water Quality Alternatives (page 3) cont'd.	Total Ratings (SS = strongly support, S = support, N = Neutral, O = oppose SO = Strongly Oppose, ? = Unsure)						Comments
	SS	S	N	O	SO	?	
A9 - Mandate and enforce best management practices	14	6	4	4		1	P7 - together with informing the public. P23 - This can't be done without doing more routine monitoring of water issues and at a far greater number of sites. Perhaps save costs by encouraging schools to participate (see A8). P24 - See A4. P25 - Which best management practices minimal or stringent. P26 - This is critical for assuring goal attainment, i.e. assumed compliance must be ensured, not hoped for. P28 - Not sure if that would be the most effective use of funds. P30 - We need staff to enforce regulations but probably only on a complaint basis. P31 - See the above series of answers (A1-A4). P32 - For new construction and businesses.
Other	P9 - move into schools-create education programs starting in grade (primary) schools P10 - strong pubic education P15 - Probably need all four approaches combined for maximum effectiveness. P16 - I realize that some voluntary/enforcement items may be contradictory. Some basic standards will require monitoring and enforcement. Currently there is the backflow maintenance required by the state for irrigation systems. Further inspection and maintenance would be helpful in new construction. P27 - Involve citizens by tours of system, maintenance activities?? (Cleaning stream shores?)						

Specific Water Quality & Detention Alternatives (page 4)	Total Ratings (SS = strongly support, S = support, N = Neutral, O = oppose SO = Strongly Oppose, ? = Unsure)						Comments:
	SS	S	N	O	SO	?	
B1- Require property owners to management stormwater	15	11	1	1			P5 - There could be situations water could be managed cooperatively. P7 - Also developers of new areas around existing developments. P12 - minimal affects may be ok P21 - Complex issue - don't think I am qualified to answer. P23 - See A2 response. P26 - The #1 goal is steam health. If neighboring property is affected by restoration of natural flows, then this alternative would impede stream health. P28 - Seems impossible in some situations. P30 - Yes. And it is the law. City staff should learn Oregon law. P31 - Absolutely! Look what has happened to the Rennie Place folks.
B2 - Provide incentives for sensitive areas	16	17		2			P15 - or mandate/require. P23 - This is the lowest cost and most environmentally appropriate approach. P26 - Incentives imply that protection is optional. I believe protection need be mandatory but assisted. P30 - Incentives - yes.

Specific Water Quality & Detention Alternatives (page 4)	Total Ratings (SS = strongly support, S = support, N = Neutral, O = oppose SO = Strongly Oppose, ? = Unsure)						Comments
	SS	S	N	O	SO	?	
B3 - City perform additional monitoring	11	10	4	2		1	P5 - monitor then act on results if needed. P13 - Nitrates and pesticides also P14 - No, that is not the City's job. P20 - Depends on density of present sampling. Oil and grease (visual) can be added at no cost. P23 - See A8 and A9. This is perhaps the <u>most crucial part</u> of the plan. Should also include flow rates, etc. Can't tell how well you're doing without adequate bench marks. See A8 and A9 as examples of ways to reduce costs. P28 - What else would be monitored and what would the cost be? Would the added information be worth the cost? P30 - Don't know what the benefits of additional information would be.
B4 - City monitor biological indicators	10	10	4	3			P4 - Could use students/classes to help monitor. P5 - monitor then act on results if needed. P6 - coordinate this with Watershed Council, ODF&W, and possibly a "stream team" - citizen involvement portion of the public and private ownership. P9 - contract with educational institute P10 - coordinate with other agencies and organizations P20 - Macro invertebrate sampling and fish counts add to one stream health database. P21 - Maybe - seems a bit excessive in day of reduced government funding. P23 - See B3. P24 - Yes - this is part of the cost of growth. P28 - Or perhaps build this into high school or middle school curriculum. P30 - Depends on the goals of such monitoring, e.g. do we try to re-establish fish population in certain reaches?

Specific Water Quality & Detention Alternatives (page 4) cont'd.

B5 - City identify and acquire wetlands	Oppose = 3	
	Support	Other/Comments: 2 marked support but did not check any of the items listed below.
Stormwater Fees on Utility Bill	19	P3 - nature conservancy, etc. P6 - grants. P15 - any are fine. P16 - all of the above. P18 - Federal grants. P20 - Wetlands already have some protection. Unclear what this would do. P24 - Taxes on waste discharges. P26 - Auto registration fees, tire tax, gas tax. P28 - Maybe a combination of these. P30 - Yes, it beats "taking". Also asked "why this" next to building permit section. Use open space funds. P31 - Utility bill rates should provide stormwater and water quality funding. The entire city needs to fund water quality remediation. The issues currently existing from past development. Other = SDC
City Bonds	14	
Property Taxes	15	
Building Permit for Redevelopment in Urbanized Area	9	

B6 - City do more to protect wetlands	Total Ratings (SS = strongly support, S = support, N = Neutral, O = oppose SO = Strongly Oppose, ? = Unsure)						Comments:
	SS	S	N	O	SO	?	P4 - encourage further native plantings and maintain existing areas. P6 - coordinate with ODF&W, Mary's River Watershed Council, Benton SWCD P9 - why just upland? P14 - Probably, but the City should not take a "heavy handed" regulatory approach. Cooperation - public education, incentives would be a preferred approach. P17 - How will this work if uplands in urban fringe? P20 - This could be used to stop all growth. While supporting open space protection, development should be judged by runoff goal and quantity. P21 - Yes - soil erosion from developments should be enforced stringently. P23 - This is the easiest and most natural way to do it. P24 - Yes - These are the last remnants of the native ecosystems which have been almost totally destroyed around Corvallis. P30 - Depends. Could cost less than doing item B5. P31 - Yes - maybe another natural resource inventory?
	11	13	4	1			

Specific Water Quality & Detention Alternatives (page 4)cont'd.	Total Ratings (SS = strongly support, S = support, N = Neutral, O = oppose SO = Strongly Oppose, ? = Unsure)						Comments
	SS	S	N	O	SO	?	
B7 - City develop standards for parking structures	4	11	7	4	1	3	P7 - Multi-story or underground P9 - parking lot redesign P14 - No - that is going too far. P15 - Encourage alternative transportation. P20 - Pervious surfaces may be a cheaper, more effective alternative. P21 - Yes - we cannot repeat HP's sprawl P23 - This is not cost effective or politically feasible. P24 - No - we should require less parking and require use of alternative transportation. P27 - Rather than build structures, use pervious surfaces for parking, e.g. in England they use grass fields for parking. P30 - No necessarily - depends on surface parking mitigation measures. Should also consider reducing parking number requirements. Should discount parking numbers and spaces in infill developments.
B8 - City establish formation of local wetland bank	7	7	3	4	1	6	P7 - Not at the expense/risk of damaging an existing wetland P10 - I would prefer that developers avoid filling or destroying wetlands P14 - The City should encourage a wetland bank, but probably not spend tax dollars to set one up. P15 - protection always better than mitigation. P17 - Does this work? P21 - Not qualified to answer. P23 - See B6. P24 - Mitigation is too often unfair and creates a substantial environmental net loss. P26 - Wetland mitigation results in a net loss of functional wetland - this idea has failed!

Specific Water Quality & Detention Alternatives (page 4) cont'd.	Total Ratings (SS = strongly support, S = support, N = Neutral, O = oppose SO = Strongly Oppose, ? = Unsure)						Comments
	SS	S	N	O	SO	?	
B9 - Streets and/or parking lots function as temporary storage area	4	18	2	3		2	P1 - No longer than necessary. P3 - 48-72 hours. P5 - Not all rainy season. P6 - as long as is necessary. You can't put timelines on nature - if there is a large problem, there's not much you can do anyhow. P7 - +-24 hours. P10 - 12 hours. P12 - Pervious areas should be maintained within the lots to slow runoff and allow percolation P14 - Yes - good idea - very innovative, I like this. 3-5 days would be ok! P15 - a week? e.g. for 100-year flood - depends on how long it lasts. P16 - parking lots and streets should have a maximum level to avoid flooding yards and basements - less than 1 week. P17 - Sidewalks exempt. P18 - 3 days. P20 - Interesting concept. Depends on storm size. P23 - Problem for water quality and not politically feasible. P24 - Yes - long as natural systems require. P25 - Max 3 days. P26 - No limit - take as long as it takes to return drainage to natural rates. P30 - 3 to 4 days. Depends on effects on adjacent users. P32 - As long as needed.
B10 - City develop guidelines and enforcement for stormwater objectives	8	9	3	2		5	P3 - change growth boundaries to BAN building on upstream areas. P7 - Much stricter preservation guidelines than DSL. P10 - local detention area requirements for developers based on before and after stream event P14 - I don't understand this question. P20 - I don't have enough data to answer this. P21 - Yes - I have seen ineffective techniques, i.e. Brooklane near City open space area. P22 - Keep soluble materials out of rain. P23 - State guidelines are weak. For instance, set aside lands can be interpreted to include far more than true wetlands. P26 - Local regulation and enforcement of: auto leaking of oil and gas and fail-safe industrial practices. P28 - If the City has different or more specific needs, then it makes sense to me to develop our own guidelines. P30 - Construction fill in floodplain, wetlands, near streams.

Retrofitting City Infrastructure to Treat Runoff in Developed Parts of the City (page 4)	Total Ratings (SS = strongly support, S = support, N = Neutral, O = oppose, SO = Strong Oppose, ? = Unsure)						Comments:
	SS	S	N	O	SO	?	
C1 - Appropriate to pipe untreated stormwater runoff into streams	1	5	5	11	3		P3 - Not best practice but ok. P13 - should be piped to bioswale. P14 - Yes, good idea. P15 - Need to move away from this. Prevention helps; reduction of impervious helps. P16 - not always. Sometimes it increases the runoff into streams beyond normal capacity. What's the percentage of pollutants? P18 - In some cases. P20 - No if it has been in contact with any potential pollutants. P21 - No - goes into Willamette. P22 - Ok where contaminants are not present. P23 - It's impossible to judge this without knowing the costs. Building a treatment plan capable of handling this is probably totally cost prohibitive. P27 - In general I would like to see less pipes and more bioswales/detention areas.
Alternative C2 - Continue/increase City practice of street cleaning	4	12	2	4	1		P3 - continue - increase where possible P7 - Status quo - Likes last sentence in C2 and would support that sentence. P9 - more education. P15 - Better than nothing. P17 - Opposes first ½ of alternative but would support "Continue/increase pollution prevention public education and outreach." P20 - As an interim measure. P23 - See C1. P28 - I guess that I would be in favor of this alternative as long as it's monitored and increasingly effective. Otherwise I would opt for Alternative 3. P32 - (underlined last sentence) Try this first. If people don't change, go to Alternative C3.

Alternative C3 - Retrofit City-owned street catchment basins	Oppose = 3	
	Support	Comments:
Stormwater Fees on Utility Bill	15	P6 - Support if people can find funding. P7 - Include installation and bioswales. P14 - No, I don't think the problem is that bad and I don't think the retrofit would be that effective. P23 - See C1. P27 - I am not familiar with this technology but would be interested in seeing some testing of this device. P30 - Try on experimental basis. Establish before and after conditions and standards. See when it does most good vs. education or disconnecting gutters, etc. P31 - New growth would be required to utilize water treatment devices. P32 - Maybe can't do everything right away.
City Bonds	10	
Property Taxes	7	
Building Permit for Redevelopment in Urbanized Area	11	
Other	P6 - Grants from private foundations or corporations. P7 - Grants. With possible $ mitigation if property owners disconnect gutters, etc. P9 - Federal programs-EPA funded TARP in Illinois. Redesign of parking lots-add French Sump Drains & trees. Parking lots should be at cost of owner P12 - Exempt new development that complies with quality standards from paying upgrade of existing facilities. P15 - any/all. P16 - any of above. P17 - Combined w/incentives for on-site implementation. P18 - Federal grants. Include installation of bioswale. P19 - If we are diligent about the other aspects of preserving water quality, treatment will not be necessary. P22 - Utilization of contaminants. P26 - Auto registration fees, tire tax, gas tax. P27 - Reduce dependance on automobiles to remove them as a major pollution source (a dream).	

Community Involvement Alternatives (page 5)

Compliance	Total Ratings (SS = strongly support, S = support, N = Neutral, O = oppose, SO = Strong Oppose, ? = Unsure)						Comments
	SS	S	N	O	SO	?	P1 - Make people aware of the fact that it floods in this general area and prepare/allow for it. P15 - Need combination of all. P17 - Multi-faceted approach would seem like it might be more effective. P18 - Retrieve tax dollars from the federal government. P22 - Keep bank intact. P28 - Education.
D1 - Individual citizens take responsibility for preventing / minimizing pollution at source	12	5	1				P1 - Here, hire. P4 - Supported through education. P7 - In part. P30 - This has to happen anyway - but need information with education/City contact.

Community Involvement Alternatives (page 5) cont'd.	Total Ratings (SS = strongly support, S = support, N = Neutral, O = oppose, SO = Strong Oppose, ? = Unsure)						Comments
	SS	S	N	O	SO	?	
D2 - Private/voluntary organizations only	6	8	9	3	2		P4 - we need all the help we can get. P9 - Could work at cross purposes should be coordinated P16 - Hard to get a large corps of regular volunteers. Hard to monitor. P18 - Especially stream watch groups. P20 - Unclear what I am responding to here. P26 - This is an option regardless of what becomes of the Stormwater Master Plan. P30 - Uncontrollable - could do more harm. Unaccountable.
D3 - Private/public partnerships	17	7	4	3			P6 - What about the City working with Watershed Council, Soil and Water Conservation District and other interested agencies and volunteer organizations to jointly support citizens' stream watch efforts? P26 - I would strongly support this if public monies were made available to support the private efforts (see D5). P30 - Best. P32 - Best!
D4 - Public only	5	9	4	8	1	2	P22 - This would not fly. P26 - This is the only alternative that suggests a commitment of resources. Resources are more important than who does it. P27 - You might get more ownership developing organizational relationships with existing departments. P30 - Uncontrollable, unapproachable, need citizen connection.
D4 (Note two D4's) - Community provide opportunities for developer sponsored, publically managed systems	11	9	2	2	1	4	P17 - Publically managed is important to maintain credibility. P24 - What does it mean - developer sponsored. P30 - Uncontrollable, unapproachable - need citizen connection.

Other	P1-Let the flood waters have room to spread over large areas. Generally this would let higher water levels sprcad out and dissipate faster. P4 - Why not involve "all of the above"? P10-School based community service options P12-Public Works assistance P9-Permanent volunteer position with City, i.e. ombudsman for nursing homes or federal or state funded position P10-More coordination and watershed groups and county-wide agencies P14 - Yes, use existing staff - <u>No Increases</u>! P15 - Need combination of all. Note "C" on page 4 and "D" on page 5 are formatted differently - these seem to want us to choose or preferred alternative. This could be more clear. (Choose 1? either/or?). A&B are each a laundry list to react to (can react to each A or B alternative independently). P18 - Adopt a stream programs. P20 - The PWD is probably not the correct agency for public education or outreach. P22 - I'm lost. P23 - All of the above, in various forms and levels. P26 - D4 comments: As non-profits utilize volunteers as standard practice, they can do the job for less money than the City while involving citizens in the process. Create a D5 = Non-profit organization or contracts: Contracting with public: Non-profit organizations bid to implement City defined citizen involvement goals and methods. Create another D5 : Commission an interactive watershed management computer model of Corvallis. Make available to Library, schools and citizens. (Create D6) Publish an EIS on the Master Plan and solicit citizen comments. If the EIS is given effort, it becomes instructional. Also solicit comments on what should be analyzed or considered in the EIS study.

Stormwater Jurisdiction Management Alternatives (page 6)	Total Ratings (SS = strongly support, S = support, N = Neutral, O = oppose, SO = Strong Oppose, ? = Unsure)						Other/Comments:
	SS	S	N	O	SO	?	
E1 - City reviews/comments on County plans and dev. applications	7	13	4	3			P20 - Not working well. P27 - One stop shopping is certainly more efficient, reduces confusion and insures compliance.
E2 - Develop City-County agreement for SW management	13	12		2	1		P6 - Create a comprehensive plan <u>and</u> agreement between City & County for management action planning. P7 - Asked how E2 and E3 were different? P10-Standards would be consistent for all of county development. More coordination between City and County. P17 - E5 - Can fringe development be controlled? P20 - E4 Should be coordinated w/Mary's River Watershed Council, SWCD, etc. P21 - Would this trigger faster development? Undesired. P23 - Be sure to include OSU Forest Plan in appropriate watersheds. P26 - (create E6) Purchase fringe land as open space to safeguard future watershed health. SS - this is what Portland is doing. P27 - E5 - Sounds great if you could pull it off, probably lots of opposition?? Other = Develop a joint City/County review team. P30 - E5 - Could get an interesting collection of political "bedfellows" on this one! E2 - P31 - But this is problematic - County not currently interested in close cooperation (e.g. latest Comp Plan review - Urban Fringe Management). E5 - P31 - This does not get basins outside of urban growth boundary. Other - P31 - Work with Mary's River Watershed Council and County.
E3 - Identify County Comp. Plan policies	15	10	1	1			
E4 - Watershed-wide education outreach	12	13	1				
E5 - Annex all UGB land promptly	4		2	8	7	4	

100-Year Floodplain Develop Alternatives (page 9)	Total Ratings (SS = strongly support, S = support, N = Neutral, O = oppose, SO = Strong Oppose, ? = Unsure)											
	Streams						Mary's River & Mill Race					
	SS	S	N	O	SO	?	SS	S	N	O	SO	?
A1 - Keep existing development standards	2	3	2	8	12		4	2	1	9	10	1
A2 - No net fill in the 100-year floodplain outside the floodway	1	3	4	10	5		1	4	3	10	4	1
A3 - Allow construction in the 100-year floodplain	4	7	7	6	2		4	10	5	5	1	1
A4 - No structural development within the 100-year floodplain	14	5	4	2			15	4	2	4		1
Other	Streams: P10-I think this will not be allowed in future due to new 4(d) Rules amounts to fish trapping. P15 - A2 & A 3 better than nothing. - What about Willamette? P16 - A1 depends on what "substantial improvements" are. P23 - The 100-year flood plain is a misnomer since we don't have the rainfall and stream flow data to back it. It is a statistical measure with many assumptions that are incorrect in current development conditions. P28 - Don't know enough about the specific areas to comment on each stream. In general, I support Alternative A3 and A4. I don't think that I support the transfer of density idea. P30 - Should be designed carefully. P31 - This is an unpopular position. I am tired of buildings being allowed in inappropriate areas and when a disaster strikes, those people ask government to bail them out of their mess!						Mary's River and Mill Race: P12-A1 north and east of Wake Robin P12-A2 north and east of Wake Robin P15 - A2 & A 3 better than nothing. P20 - A2 Must examine affect on hydrology of flood not simply balance cut and fill. P20 - A3 w/restrictions. Access must be addressed. P26 - create A5 - Same as A3 but allows no industrial development within the floodplain (chemical release hazard).					

Additional Floodplain Management Questions (page 10)	Total Ratings (SS = strongly support, S = support, N = Neutral, O = oppose, SO = Strong Oppose, ? = Unsure)						Comments
	SS	S	N	O	SO	?	
B - Provide incentives for floodplain restoration/protection	11	14	2	2		1	P6 - (circled approaches) Such as? P7 - anything that protects & restores P26 - I believe we're referring to mitigation.
C - Create on-going floodplain protection/restoration opportunities	7	8	3	7		5	P9 - change density P20 - What is envisioned? P23 - If done properly, the possible costs listed do not have to occur. Be sure to include OSU MacDonald Forest Plan, for example. P26 - I believe we're referring to easement acquisition. (Circled contributing to urban sprawl and noted:) False perspective - restoration and protection do not cause sprawl. This is exclusively the result of increased population and our resistance to live at greater density. Let us not try to shift the blame on to an entity that has no control over our activities, demands and politics.) P28 - What would be the incentive here?

Other	P1-Hold our City and State governments and personal (sp?) responsible for decisions concerning flood related project liable for mistakes/blunders. P26 - Create D - Annex and purchase (by City) fringe property to swap for private lands in floodplain.

D (page 11) - Would you support the purchase of buildings and land in the floodplain?			Oppose = 2	Oppose = 2 Neutral = 1
	Support	Comments:	Support Floodway	Support Floodway Fringe
Stormwater Fees on Utility Bill	11	P15 - use higher density!	22	16
FEMA (Federal Emergency Management Agency) Funds	15			
Open Space or Other Bond Money	14			
Other:	P6 - Grants/foundations P15 - Any/all. P18 - Get back some money from Feds and use it to purchase open space and floodplain. P20 - Habitat restoration grants. P23 - Write grants to conservation organizations, etc. P26 - Donations, grants, general fund revenue derived from increased property tax payment caused by increased real-estate values near to public floodway acquisition. P31 - Prioritizing land purchase based on floodplain.			
Comments:	P9 - not an option, increase density. P12-as long as willing sellers are not coerced into selling by withholding permits. P15 - Change zoning - encourage more compact/dense development everywhere! Need to decrease footprint of development on land. P17 - Would be more supportive if u. sprawl could be eliminated as possible result. P22 - Character of soil of area under consideration.			

E - Do you think the land outside of the 100-year floodplain be subject to guidelines?	SS	S	N	O	SO	?
	5	11	4	2	2	1

Comments	P9 - Isn't a 500-year event the whole City? P14 - Yes - there should be guidelines, but they should be less restrictive than development in the 100-year floodplain. P15 - I'd support this but most people wouldn't - not realistic. Guidelines like A2 would help. Flow big is (e.g.) 200-year floodplain? 500? P20 - Being off of the 100-year floodplain does not ensure no flooding. The capacity of soil to absorb water, slope stability and other factors come into play. Preparing for a 500-year event is a daunting task. P22 - With consideration of up stream dams on Willamette River. P23 - See IV, A4 comments. P27 - Focus on 100-year floodplain issues first. P32 - Let's work on 100-year floodway fringe first

F - (Page 11) Should yards in new residential development be located within the 100-year floodplain?	Floodway	Floodway Fringe	Comments
	SS/S = 7 N =4 O/SO = 12 ? = 1	SS/S = 11 N = 6 O/SO = 4 ? =	P7 - Yes if landscaping and filling is regulated so there aren't conflicts. P15 - if yes then have requirements for yards to maintain natural vegetation, channels, etc. P17 - Move to develop more natural asthetic of domestic landscape that would accept naturalized riparian planting and topography. P20 - Floodway - small streams allow them. Floodway fringe - small streams ok. P20 - No new development should be allowed in the Mary's River floodway. Ok within fringe of Mary's River when it meets land use objective. P22 - Review of last 100 years weather data. P24 - Unless they are organically managed with native vegetation. P32 - Floodway fringe area - support if no chemicals are used on it.

	Total Ratings (SS = strongly support, S = support, N = Neutral, O = oppose SO = Strong Oppose, ? = Unsure)						
Stream Corridor Width Alternatives (page 15)	SS	S	N	O	SO	?	Comments
A1 -Existing	3		6	10	5		P15 - Better than nothing. P23 - This techniques is totally inadequate for the very narrow, small channels that exist in the upper reaches of any of the basins. However, many of these represent the last opportunities for natural protection.
A2 - Up to 100 feet	1	9	4	7	2	1	P14 - Fairly high standard with some flexibility! P17 - I'm very concerned about sprawl issues and a walkable City and am concerned about gaps in the City form. Can stream corridor widths be reduced or require more specialized development with stricter out of corridor standards?
A3 - Up to 150 feet	3	8	3	7	2		P23 - See A5 comments.
A4 - Up to 200 feet	14	1	1	5	3		P15 - or just 200' no matter what? Don't have max. of 200' - need wider area than this to protect natural functions in some areas, e.g. the Willamette needs a stream corridor more like a mile (or 10!) P24 - I think the urban sprawl disadvantage is misleading. Wider corridors will not cause urban sprawl and we, as a community, can both protect ecological systems and stop sprawl. P27 - Prefer one standard 200' buffers with an except policy where development can be mitigated to support riparian area. P32 - Need to allow for stream migration.

	Total Ratings (SS = strongly support, S = support, N = Neutral, O = oppose SO = Strong Oppose, ? = Unsure)						Comments
	SS	S	N	O	SO	?	
A5 (Page 15) - Standard set widths of 50, 100 and 200 feet	4	5	5	8	2	1	P14 - Need more flexibility. P15 - Strongly support if 200' minimum everywhere. Important to keep these if greater. P23 - Probably is direction to head because addresses differences between stream segments. However, fixed rules based strictly on formula create significant potential to have too small or tool large areas dedicated. See A1 for upper reaches concerns.

Other	P6 - also for seasonal streams.

Stream Corridor Supplemental Questions (page 16)

General Question: Does your home or business property border a stream?	Yes	No	SS	S	N	O	SO	?	Comments:
	12	16							P20 - But it probably was a wetland in 1950. P22 - Proportion of roof.
B1 - Floodplain - Should the stream corridor width be wide enough to include the entire 100-year floodplain?			10	7	2	2	2		P26 - But not for all cases. Include land outside boundary to make-up for land developed inside boundary. P30 - Depends on stream, location.

B2 - Minimum width different than 50 feet?	Yes	No	Greater Than 50'	Fewer than 50'
	13	11	6 ?=1	2 ?=1
Comments: P20 - Have you defined a stream? Perennial? P22 - Depends on slope. P24 - Pre-contact (development) corridor width.			Comments: P14 - 100' P15, P18 & P27 - 200' P19 - 100'? Depends on situation. P23 - 100' or more P26 - 70'	Comments: P6 - Additional 25' - 50' (total 75') P21 - at least 50' - dependent

Stream Corridor Protection, Enhancement & Restoration (page 16)	Total Ratings (SS = strongly support, S = support, N = Neutral, O = oppose, SO = Strong Oppose, ? = Unsure)						Comments:
	SS	S	N	O	SO	?	P15 - Probably need all of these. P22 - Other - bridges are better than culverts for stream passages. P26 - Create C5 - Impose a limit on the watersheds effective impervious land cover of 15%. By "effective", a parking lot does not contribute if its run-off is delayed by some mitigative measure.
C1 - City should provide incentives for stream corridor restoration	13	12	1	2			
C2 - City should create ongoing stream corridor protection/restoration	13	11	1	3			
C3 - City should create a land use ordinance/guidelines for riparian comm.	11	13	4	1			
C4 - City should develop program for information outreach	15	11	2				

Ownership of Stream Corridors (page 16)			
D1- Should stream functional corridors be placed in public or private ownership?	City-owned SS/S = 11 SO/O= 1 ? =1	Privately-owned SS/S = 6 SO/O= 5 N = 2 ?= 1	Ownership should vary depending on situation SS/S = 17 SO/O = 3 N = 1 ? = 1
D2 - Should either a conservation easement or acquiring a stream functional corridor outright be the preferred method for stream acquisition?	Acquire land SS/S= 11 SO/O= 1 ?= 1	Acquire conservation easements SS/S = 7 N = 5 SO/O= 2	A mix of both acquisition & conservation easements SS/S = 19 SO/O = 1 N = 0 ? = 2
Other	P9 - size of stream critical location P15 - D1 - publically or non-profit owned would yes/ss. P31 - Greenbelt Land Trust understands this issue well.		

Additional Stream Corridor Alternatives & Associated Questions cont'd. (page 17)	Total Ratings (SS = strongly support, S = support, N = Neutral, O = oppose, SO = Strong Oppose, ? = Unsure)						Comments
	SS	S	N	O	SO	?	
E1 - Funding acquisition of stream corridor land	6	4	5	2	1	1	
E2 - Existing approach	4	7	5	3	1	2	
E3 - Shared acquisition costs	9	7	3	3	1	1	P12 - This would be an acceptable alternative if the costs only pertained to a facility that was acceptable to developers's needs.
E4 - Shared costs between SDC and community	6	7	3	4	1	2	
E5 - Purchase through public funds	5	13	1	2		2	P16 - I would not like to stifle any opportunity to acquire the land for this purpose.
Other	P1 - tax incentives/breaks P9 - Federal, state, other? P15 - Combination of all probably needed - support any/all. P22 - Bonds P23 - Write grants to conservation organizations and foundations.						

F - Stormwater Fees on Utility Bill	11	Other/Comments:
FEMA (Federal Emergency Management Agency) Funds	16	P6 - Grants. P15 - any/all
Open Space or Other Bond Money	16	P16 - any/all P18 - Federal monies. (circled D2, D4 and/or D5) Where?
Property Taxes	6	P19 - Nature conservatory organization? P26 - Auto registration fee, tire tax, gas tax.
Unsure	2	

	SS	S	N	O	SO	?	Comments:
G (Page 17) - Swales	9	15	2				P10 - More detention with delayed release. P12 - Only to the extent necessary to service the area. P16 - Yes, there is currently year round stream flow in this area - no dry out in any time period. This has changed since 1996. P23 - This is key to natural protection and least invasive. P26 - Absolutely. These areas perform an important hydrological and ecological role. Allowing their development or clearing will destroy this function.
H - Water treatment siting	4	12	2			7	P9 - possibly P15 - Not sure of pros and cons. Need to protect natural functions of stream and water quality in stream. P26 - Depending upon size and frequency of maintenance and equipment required to do maintenance. The bigger, more frequent and heavy equipment dependent systems should be located away. P27 - if it will not effect stream habitat. P30 - Need more information. How effective is it? Are they unsafe for kids?
I - Recreational access	3	10	3	6	2	1	P7 - not trails, but P9 - with appropriate protection of riparian zone. P14 - only if the stream corridor is publicly owned. Or if the private landowner is agreeable. No access forced on unwilling private landowners. P15 - Stream protection more important than recreation. P17 - If access precedes development is easier - but does it serve riparian function? P19 - Would increase public support and appreciation of your effort. P20 - Where appropriate. P26 - We need this connection to the ecosystem. We have ability to destroy by lack of thought. P27 - if it will not impact stream habitat/functionality. P30 - Probably inappropriate where riparian habitat preservation is major goal. P32 - At a distance from stream so there isn't much development (i.e. narrow paths, etc.) for walking, etc.
J - Natural vegetated corridors	11	9	2	4			P19 - Depends on impact potential flooding. P20 - Some management will always be required. P23 - With the exception of locations where this would probably lead to localized flooding of property. P24 - Of course. P26 - Absolutely! P30 - Yes, as long as meets fish mitigation and other environmental goals - and do not increase erosion where existing structures are threatened. P31 - Trees should be removed if they take away from stream function, course, etc. P32 - Yes.
Comments	P24 - Natural systems are the cheapest (long term) most lasting systems. Let's stop fighting natural systems.						

Water Quality Management

Stormwater quality management addresses storm water quality, including pollutants in streams, wetlands and ground water, sediment transport, and water temperature. Existing federal regulations (1999) will require greater levels of stormwater pollution control and prevention in Corvallis in the near future.

Policy No.	Policy	Comments
*QL-1	Sediment removal using Best Management Practices shall be used prior to discharge of all runoff from both public and private impervious areas.	1. Define Best Management Practices 2. What is the exact definition you are using for "Best Management Practices"? What are the "measures"? How is the problem to be quantified and monitored?
*QL-2	Lands set aside for water quality improvement such as vegetated swales, detention facilities and open channels, shall be maintained to function properly. Responsibility for maintenance shall be determined at the time these facilities are reviewed by the City for approval.	
QL-3	The City shall determine beneficial uses for streams within the Urban Growth Boundary and monitoring them to assess if streams support beneficial uses or are water-quality limited.	1. What specifically are "beneficial uses"?
QL-4	Investigate the feasibility of ensuring that stormwater is not discharged directly into streams.	1. Should this policy be rewritten to..."The City shall ensure that stormwater is not discharged directly into streams without pretreatment/filter." 2. Does this mean prior to some type of pretreatment, if so, what type of pretreatment?
*QL-5	The City shall develop programs and policies that preserve and enhance stream corridor vegetation on both public and private lands.	
*QL-6	The City shall develop policies and programs to limit stormwater pollutants from entering streams from sources such as pet waste, vehicle wash water, household and business chemicals, and other community waste products.	
*QL-7	The City shall develop policies and programs to control construction site erosion that: a. Require an erosion control plan for all construction activity that can potentially cause erosion. b. Prevent construction site erosion through proper construction techniques. c. Provide erosion control guidance to the development community in the form of an erosion control handbook. d. Require sediment removal (to the maximum extent practicable) from construction sites runoff prior to discharge to stormwater systems or streams. e. Enforce erosion control measures through an active enforcement program by educating the public and the building inspectors on the importance of erosion control. f. Develop community specific standards that limit sediment discharge into receiving water bodies.	1. Please go look at the house on the corner of Glenwood Drive and Fair Oaks in Skyline West (6370 Fair Oaks Drive). That should <u>never</u> be allowed.
*QL-8	The City shall continue and expand monitoring for bacteria in streams as well as source-water to develop a better understanding of the conditions and sources of bacteria.	1. Why only monitor bacteria?

* Policies that the City is currently doing, at least in part

Policy No.	**Water Quality Management continued....** Policy	Comments
*QL-9	The City shall develop chemical use guidelines (for both public agencies, private property owners, and landscape maintenance specialists) involving pesticides, herbicides, and fertilizers that minimize the flow of chemicals into the stream system	2. I hope the city will be very active and through in implementing policy **QL-9**, the chemical use guidelines. This policy should also be expanded to include reporting of what chemicals are used that could enter our stream systems. 3. The guidelines for pesticides, herbicide and lawn chemical use should not be limited to the public sector. They are only guidelines not rules.
*QL-10	The City shall develop a program to sweep public parking lots.	1. These aren't all bad policies, by any means, but money is an issue - how much will it cost to sweep public parking lots, if it is not already being done?
QL-11	The City shall develop requirements for cleaning surface parking lots and private catch basins.	1. What does this mean? What will it entail? Will it be prohibitively expensive? Am I going to have to go out and scrub my driveway every week? Is this going to amount to nothing or is it going to translated into something draconian? 2. Should the word surface be "private"? 3. Policy **QL-11** should be adopted because private parking lots degrade streams and rivers just as much as public parking lots.
QL-12	The City shall protect key areas of exchange between ground and surface waters, such as springs, unconstrained reaches of streams and drainages upstream.	1. Very important to the issues raised with respect to Jackson-Frazier Wetland.
QL-13	The City shall prohibit installation of overhead utility lines along streams that are in conflict with management of vegetation that provides shading.	1. It is often desirable to maintain tall vegetation to provide shade for temperature control.
*QL-14	The City shall create opportunities to protect and enhance stream channel structure for deeper pool habitat that provides cooler water refuge areas at times of low stream flows.	

Floodplain Management

Floodplain management addresses the functional roles of floodplains for storm water in urban areas, and the implications of, and guidance for activities within the floodplain. A major purpose of floodplain is to temporarily store excess water. Current city regulations allows filling and flood water-displacing structures in the floodplain. In small streams, this can increase flow velocities and erosion, and conflicts with its hydrological role.

Policy No.	Policy	Comments
FP-1	The City shall acknowledge and accommodate natural flooding within the floodplain, and avoid or minimize urban-created flooding patterns.	1. (Minimize urban-created flooding was underlined) How do you do that without eradicating the urban environment? 2. It is very important to ensure that the Floodplain functions properly to protect water quality. To this end I think it is appropriate to adopt all of the policies listed under Floodplain Management: **FP-1** through **FP-12**. I think it is particularly important to control and minimize development within the 100-year floodplains of local streams. This kind of Floodplain management does have economic consequences that should be the responsibility of the entire community rather than falling on a few individuals. Therefore, it is important to adopt Policy **FP-5** so that development restrictions will effect public land rather than private land to the greatest extent possible.

* Policies that the City is currently doing, at least in part

Policy No.	**Floodplain Management continued....** Policy	Comments
FP-2	The City shall complete mapping and inventory of floodplains and the 0.2-foot floodway within the Urban Growth Boundary.	1. The limits of the 100-year floodplain and the 0.2 foot floodway should be updated as new technologies and methodologies for determining the extent of those features become available.
FP-3	Development of new buildings on green field sites shall be prohibited in the 100-year floodplain of local streams.	1. "Local streams" - where along those local streams does the local stream 100-yr. floodplain end and the Willamette and Mary's floodplains begin? 2. Too restrictive given other development policies and the extreme shortage of affordable housing. If we don't want sprawl, we can't also have this policy. 3. Define local streams. 4. Floodplain acreage in local stream is not great. Need to define "green fields " in glossary.
FP-4	Infill and redevelopment in the 100-year floodplain shall not alter the pre-existing stormwater functions and shall be constructed in a manner that does not restrict or otherwise alter proper floodplain functions using techniques such as elevated structures, flow-through designs, more pervious surface area, and reduced building footprints.	1. You should look at the cost of using this policy and throwing out FP-3 and FP-5. 2. Isn't clear that this is for small streams.
FP-5	The City shall develop a program for acquiring land and easements that become available within the floodplain.	1. <u>At least</u> \$2 to \$3 million, this policy has to go. We can't afford it and it could never be implemented. 2. Concerning the buy-up of 100-yr. floodplain lands - you <u>cannot</u> calculate the approximate percent within the 0.2 ft. floodway out of the costs. If the land purchase has floodway in it, landowners <u>do not</u> sell only the land outside of the floodway, thereby making the purchase price less. If a piece of property goes for \$100,000 per acre with floodway in it, this means that land without a stream running through it is likely going to cost substantially <u>more</u> than \$100,000. Quit trying to pretend that policy number FP-5 is not really going to be expensive. I don't know if it's willful stubbornness or a conscious attempt to hide the problem, but this back peddling on the cost of floodplain purchase policy is beginning to be silly. Just get rid of FP-5. 3. Purchase of land in the floodplain by the City is a cost-effective approach to minimization of loss of expensive, but poorly located, development and possible loss of lives during flood events. 4. Often productive uses of these lands are available other than for structural development.
FP-6	The City shall protect hydrological processes to support self-sustaining levels of native fish, aquatic species, and wildlife populations.	
FP-7	City infrastructure, including sanitary sewers, should be located outside the 100-year floodplain and wetlands unless it can be demonstrated that they will cause no harm to the properly functioning condition of the stream and that no other reasonable option is available.	1. What is the reason they are currently located in the 100-yr. floodplain? It <u>seems</u> like a reasonable policy, but what's being left unsaid? What's wrong with using FP-4 for <u>any</u> development in the 100-yr. floodplain, whether infill, redevelopment, or new development on "green field" sites? 2. For example a storm sewer across Jackson-Frazier Wetland would be hydrologically disruptive.
FP-8	Area-specific development standards for the Marys and Willamette Rivers should be instituted to maintain stormwater functions that are proportional to their effect on the receiving water bodies.	1. Leave this to FEMA standards, as FEMA considers the whole drainage basin not just our local streams. 2. Should not such standards be applicable to all streams?
FP-9	The City shall develop and implement incentives for floodplain protection, enhancement, and restoration as part of the development process.	
FP-10	Developers shall provide accurate floodplain mapping with their development applications.	
FP-11	The City shall allow for a variety of low impact activities on public and privately owned floodplain lands (such as parks and sports fields) so long as it can be demonstrated to protect floodplain functions.	

* Policies that the City is currently doing, at least in part

Policy No.	**Floodplain Management continued....** Policy	Comments
FP-12	The City shall develop strategies that accommodate housing and other development opportunities that are displaced by floodplain protection measures to ensure a compact development pattern.	1. How? If you make all your more "affordable" lands unavailable for development, how and where are you going to put "poor" people, which around here means families earning less than about $50,000 per year? 2. Density transfers, which one property owner can transfer to another?

Stream System Management

Stream system management addresses various techniques that are available for managing streams and riparian areas for storm water objectives, while maintaining or reestablishing the ecological properly functioning condition of the systems. Urban stream corridors are also of value to reduce the need for ongoing stream corridor maintenance costs, and to allow for channel changes without putting homes in jeopardy.

Policy No.	Policy	Comments
SS-1	The City shall inventory and identify intermittent streams within the Corvallis Urban Growth Boundary that provide important hydrological and habitat functions. Those found to be significant shall be protected using mechanisms such as drainageway dedications and easements.	1. Are intermittent streams found to be significant included in the rest of the stream policies? 2. Policy **SS-1** is a very important part of overall stormwater management because intermittent streams are a very large part of natural water holding. We need a good inventory of intermittent streams and we also need the inventory of stream conditions that would be provided by **SS-6**. 3. Too little attention is paid to these minor systems, yet they account for much sediment that adversely effects water quality.
*SS-2	The City shall provide urban stormwater management practices that utilize the streams natural features and processes without conflicting with or degrading the stream systems other ecological functions.	
*SS-3	On public projects, the City shall incorporate stream habitat improvement and shading.	
*SS-4	Identify all City-owned land, including dedicated stream corridors and parks and open space, in order to prioritize opportunities for stream and riparian habitat improvement.	
SS-5	The City shall develop standards for stream corridor widths in order to protect stormwater functions. The width shall be determined based on the following stormwater functional objectives: a. Preserve the hydrologic conveyance and storage capacity; b. Allow for natural channel lateral migration and bank failure; c. Allow for channel widening and other channel modification that result from changes in hydrology from future urban development; d. Properly shade the stream to maintain or improve water quality; e. Allow for a vegetative management strategy that deters unwanted species; f. Provide for a pollutant filtering zone for surface runoff; g. Allow for natural stream processes to minimize stream channel, bank, and corridor maintenance needs; h. Buffer urban uses from stream processes; and i. Provide for a source and delivery of large wood.	1. 5b, not sure about consistency through all the policies regarding "erosion". Criteria say "unwanted" erosion should be controlled. Here bank failure is allowed. Some bank stabilization actually causes other bank destabilization. What's "unwanted" erosion? When is bank stabilization necessary? 2. How we develop near streams is crucial to create and maintain effective stormwater management. Therefore, I hope both **SS-5, SS-7** and **SS-8** are adopted, but it seems like they could be combined into one policy. 3. Present calculation of corridor width to be protected is too narrow and does not provide adequate shade for fish and buffer for sediment and pollutants entering the stream. Reasons listed are all important. It may be necessary to accompany the corridor-widening program with a compensation program.
SS-6	The City shall prepare and maintain a citywide inventory of stream conditions based on stream reaches.	

Policy No.	**Stream System Management continued....** Policy	Comments
SS-7	The City shall develop and implement standards and programs that preserve the properly functioning condition of the stream including habitat, hydrologic function, historical stream meander, and avoid hardening of stream banks.	
SS-8	The City shall ensure that shading is provided along streams to maintain or improve water quality. Where stream shading is not adequate, development should include planting of trees to provide shading.	
SS-9	The City shall develop policies and standards that enhance or restore degraded channels, riparian areas and floodplains.	1. Delete "develop polices and" 2. **SS-9** is an important policy to include because we have plenty of degraded floodplains.
SS-10	The City shall inventory and prioritize the viability of replacing culverts with bridges to improve stream function and fish passage.	1. Delete "and prioritize the viability of replacing" and substitute replace.
*SS-11	The City shall develop programs and policies to protect and restore native riparian vegetation along drainageways.	
*SS-12	The City shall consider minimizing stream crossings from roads, utilities, and other development activities.	
SS-13	The City shall develop policies that encourage the use of natural areas adjacent to stream corridors for enhanced stormwater functions, such as bioswales.	1. Especially important for water quality improvement and to permit a linear system of trails connecting other open space units.
SS-14	Public access to and along stream corridors shall support the properly functioning condition of the streams.	1. How about: "Public access shall only be allowed along stream corridors if they do not impact the property function condition of the streams".
*SS-15	The City shall modify maintenance practices to enhance and protect stream conditions.	

Water Quantity Management

Water quantity management addresses how rainfall and other water is managed when it enters and travels through the Corvallis urban landscape. Natural movement of water involves both surface and underground storage and transport. Urban development alters water movement patterns within the urban area, including stream flows and wetland hydrology.

Policy No.	Policy	Comments
*QN-1	Through rational engineering analysis, the City shall establish stormwater detention and release standards for new development that preserves or restores the properly functioning conditions of the receiving waters	1. Can you do this without spending millions? 2. What is "rational"? Is there irrational engineering analysis? 3. The word rational should be changed. There is a rational design method for storm drainage that may not be what is intended.

* Policies that the City is currently doing, at least in part.

Policy No.	**Water Quantity Management continued....** Policy	Comments
QN-2	In order to reduce peak runoff from impervious areas and maintain pre-development flow regimes, the City shall consider adopting the following standards: a. Minimize the proportion of each development site allocated to surface parking and circulation. b. Minimize the average dimensions of parking stalls. c. Use pervious materials and alternative designs where applicable. d. Modify setback requirements to reduce the length of driveways. e. Promote the use of shared driveways to reduce impervious surface in residential development. f. Promote disconnection of roof down spouts to reduce runoff going into a piped collection system or the street. g. Retain a larger percentage of vegetated area within all types of development to increase rainfall interception. h. Pursue the use of retention and infiltration facilities where the soils are suitable to control runoff volume, peak flow and promote dry season base flows in streams. i. Develop sub-surface storage as well as surface detention facilities. j. Evaluate additional restrictions on cuts in hillsides, especially in areas with near-surface groundwater.	1. Be realistic; you aren't going to "go back" to actual pre-development conditions without eliminating development, and this is not something that can be done in a city where people live. What's the goal...make Corvallis go away? 2. Our soil is <u>dense-clay</u> but it <u>accepts drain water</u> - holds a lot of it. On nearly level sites, such as 1525, 1535 SW Brooklane Drive, well constructed gravel (under lain with landscape cloth) drives & parking spaces will drain adequately without storm sewer access. A 6' deep 18" diameter dry well functions to satisfactorily drain an asphalt drive at 1535. A horizontal perforated pipe approx. 100' long adequately drains impervious driveway at 1525. Code should be changed to allow pervious surfaces for new driveways & parking lots. Dry wells about 12' deep, 18" diameter with vertical perforated pipes can be retrofitted to drain parking lots in need of improvements. Change codes to put stormwater in ground. Bob Stebbins, 754-8039. 3. 2d, needs to be coordinated with Land Development Code requirements. 4. 2j, this should be based upon site specific geotechnical investigations. 5. Since I live in the house closest to the confluence of the Willamette and Marys rivers, minimizing the rate of peak runoff is *very* important to me. Therefore, I hope **QN-2, QN-3, QN-7, QN-9, QN-10, QN-11, QN-12, QN-14, QN-15** and **QN-16** will be adopted. 6. I like the policies allowing pervious materials for parking lots and disconnection of down spouts where appropriate. Care in wording of the policy and in implementation is needed to avoid increased infiltration in areas where this will cause increased slope instability. Innovation should be encourage. 7. Consider soils retention/capacity and infiltration, use dry wells, increase pervious/OT coverage. 8. See above discussion of Jackson-Frazier Wetland.
QN-3	The City shall develop public infrastructure that provides for temporary detention in areas primarily dedicated to other uses, such as parks and open space, parking, and streets.	
QN-4	The City shall encourage practices that enhance groundwater recharge to maintain or increase stream flow during dry periods.	
QN-5	The City shall differentiate between natural flooding and urban-created flooding regimes and allow for natural flooding to occur while minimizing urban-created flooding regimes.	Reference FP-1: These two policies, along with QN-2.
*QN-6	The City shall develop standards for detention facilities, including location, slope, and vegetation. Detention facilities shall not be constructed within existing stream corridors, but may discharge into streams.	1. See above discussion of Jackson-Frazier Wetland.
QN-7	The City shall consider the amount of impervious surface when evaluating detention requirements and develop a policy to encourage recharge opportunities.	1. Recharge what? Groundwater?
*QN-8	The City shall develop water quantity maintenance practices that protect, enhance and restore the vegetative canopy along drainageways.	
QN-9	The City shall use maintenance policies that enhance the natural detention capacity and upstream storage capacity of urban streams, such as retaining vegetation and wood and allowing beaver dams to remain in-stream.	1. There are many natural processes that can work for our benefit without excessive cost.

* Policies that the City is currently doing, at least in part.

Policy No.	**Water Quantity Management continued....** Policy	Comments
QN-10	The City shall provide incentives to developers for incorporating existing vegetation and open spaces into permanent stormwater facilities.	1. What type of incentives, need some definition (i.e. density transfers)?
QN-11	The City shall consider incorporating detention capacity in existing pipes and open channels when replacing or retrofitting the storm drainage system.	
QN-12	The City shall consider acquisition of land and easements for future detention facilities.	
QN-13	The City shall develop standards for managing urban runoff to allow for innovative building/landscape designs if it can be demonstrated that existing building standard consistency can be maintained.	
QN-14	The City shall develop standards to manage surface flows on developed sites to increase the time it takes for the water to reach the stream.	
QN-15	The City shall incorporate detention and water quality features into street and parking lot rehabilitation projects.	1. Public or private projects? Or both?
QN-16	To manage stormwater drainage and provide direction for developing standards, the City shall establish parameters and/or objectives for allowing new development to use vegetated swales or open channels.	1. Yes!

Uplands Natural Resource and Wetlands Management

Uplands natural resource and wetlands management addresses the roles of uplands natural features and wetlands to storm water management, and the implications of urban activities in these areas. Uplands natural features that provide for storm water management include rainfall-storing vegetation, ground water, and natural swales that are the upstream sections of stream systems.

Policy No.	Policy	Comments
*UP-1	The City shall modify its operation and maintenance practices to protect, enhance, and restore upland natural resource areas and their functions and processes.	
UP-2	The City shall identify upland natural areas and significant natural swales within the Corvallis Urban Growth Boundary that provide important hydrological and habitat functions.	1. Since I live in the house closest to the confluence of the Willamette and Marys rivers, minimizing the rate of peak runoff is *very* important to me. Therefore, I support adoption of policies **UP-2** through **UP-10**.
UP-3	The City shall develop stewardship guidelines that protect natural stormwater functions and processes associated with wetlands, natural swales, and vegetation.	
UP-4	The City shall encourage the Division of State Lands to fully implement and enforce wetland protection goals and regulations within the City of Corvallis and the Urban Growth Boundary to maintain hydrological and natural resource functions.	
UP-5	The City shall develop and implement incentives for developers and property owners to protect, enhance, and reestablish wetlands, natural swales, vegetation, and groundwater for stormwater functions.	

* Policies that the City is currently doing, at least in part.

Policy No.	**Uplands Natural Resource and Wetland Management continued....** Policy	Comments
UP-6	The City shall explore opportunities to acquire lands to preserve stormwater functions through outright purchase, conservation easements, and partnerships.	
UP-7	The City shall consider applying hydrological and habitat function-related policies to natural swales.	
UP-8	The City shall encourage wetland mitigation to occur in the same basin, unless it can be proved that other wetland functions outweigh the lost functions.	1. Wetland mitigation outside the basin in which the wetland is lost, except in extraordinary circumstances, is not giving the public the benefit of the lost wetland. Each wetland serves a different function, has a different value. 2. Clarity intent. 3. "Basin" needs defined. 4. Currently most wetland mitigation takes place away from watersheds in which wetlands are impacted, e.g. mitigation for a Corvallis development in Lebanon! The City might consider developing its own mitigation bank, or better yet, a mitigation bank in each watershed.
UP-9	Wetland mitigation should not compromise the existing stormwater functions of the land being used for the mitigation.	
UP-10	New development and redevelopment should not inhibit the quantity and quality of water reaching wetlands.	1. See above discussion of Jackson-Frazier Wetland.
*UP-11	The City shall place a high level of significance on wetlands that are adjacent to streams.	

Cross-Jurisdictional Basin Storm Water Management

Cross-jurisdictional basin storm water management addresses watershed stormwater issues that cross jurisdictional boundaries, including flow, water quality, wetlands, and the vitality of streams. All of Corvallis' local streams and their watersheds extend beyond the current city's limits and the urban growth boundary into Benton County jurisdiction.

Policy No.	Policy	Comments
CJ-1	Governing agencies shall work to develop a basin-wide stormwater management approach with common goals and objectives.	
CJ-2	The City shall develop cooperative agreements with surrounding jurisdictions to protect streams and habitat throughout the entire watershed.	1. There is especially a need for the county to work together with the city.
CJ-3	The City shall work with Benton County to update the Corvallis Urban Fringe Management Agreement to adequately address stormwater management. Surrounding Counties may also be part of the basin-wide management strategy.	
*CJ-4	The City and County shall encourage public participation and information outreach activities for all citizens within the watershed.	

* Policies that the City is currently doing, at least in part.

Public Participation and Information Outreach

Public participation and information outreach to meet storm water objectives can occur in a number of arenas, including improving or protecting water quality, stream and wetland health, and storm water detention. Citizen involvement can range from watershed programs to backyard practices.

Policy No.	Policy	Comments
PP-1	The City shall evaluate and seek funding for the resources required to meet public participation and information outreach objectives.	1. Don't do that if you're going to rely on scandalously bogus surveys, like you did for the SWMP project. I don't know how anybody can trust you when it comes to the citizen input stuff.
PP-2	The City shall establish information outreach programs that target what individuals can do to take personal responsibility for controlling sources of stormwater pollution and the health of streams.	
PP-3	The City shall provide stream stewardship guidelines for stream-side property owners.	
PP-4	The City shall develop incentives that maintain and enhance the health of the stream systems.	
PP-5	The City shall develop and support stewardship programs such as "adopt a stream" and neighborhood association "stream watch" to monitor and enhance stream and riparian habitat. Resources from other agencies and programs should be used in this effort.	1. The Benton County Soil and Water Conservation District is currently working (informally now) with the City of Corvallis Public Works Dept. (Water Utility) in the beginning stages of starting this very program. Grants from agencies and private foundations are pending and a decision should be available from the potential funders by the end of September, 2001. If we are successful, then we can start the very beginning steps....The Benton SWCD will assist with watershed education-service-learning projects with local schools and neighborhood associations. For more info., contact Director Mary Eichler of Benton SWCD staff at 753-7208. The Benton SWCD can help with jurisdiction concerns - as an education and tech. assistance agency.

Suggested Follow-Up Actions

Suggested Follow-Up Action		Comments
Water Quality	The City shall investigate other stormwater quality management techniques that are used by other agencies and implement as appropriate.	
	The City shall retrofit catch basins to improve water quality.	
Floodplain	The City shall investigate the feasibility of constructing bridges to span the 100-year or a portion of the 100-year floodplain of permanent stream corridors or otherwise maintain connections in the floodplain (such as multiple culverts). It is recommended that this investigation look at whether to develop different stream-crossing standards for stream floodplains and the Willamette and Marys Rivers floodplain and backwater areas.	
Stream System	The City shall investigate ways to restore natural stream habitat function and other methods to mitigate high stream temperature.	
	The City shall investigate ways to protect existing stream systems, including channel, riparian area, and floodplain for both permanent and intermittent streams.	
	The City shall identify intermittent streams within the Corvallis Urban Growth Boundary that provide important environmental functions.	

	Suggested Follow-Up Action	Comments
Stream System continued...	As part of the current land development code update, revise stream-width dedication formula to meet identified stormwater management needs.	
Water Quantity	Recognize that the best efforts to mimic "natural" peak flood volumes and frequencies will probably not entirely maintain pre-development flooding regimes. Therefore, we should design appropriate stormwater infrastructure, such as stream corridor widths, to accommodate those changes, including destabilized and widening channels, changes in the erosion and deposition patterns, etc.	
	The City shall identify steep terrain and consider implementing development standards for reducing impervious surfaces in these areas.	
	The City shall identify the maximum runoff from impervious upland areas that is necessary to protect hydrological and habitat functions of areas downstream and consider development standards that maintain flows below the maximum.	
Upland Natural Resources	The City shall consider exceeding existing state and federal requirements for wetland protection.	
Cross-Jurisdictional	The City and County shall identify watershed protection and restoration opportunities that involve multiple agency and/or property owner partnerships.	

General Cost Questions/Comments:

1. Look for $$ from private sources where budget shortfalls occur (foundation).
2. A citizen mentioned that if a cost benefit analysis was done, it would show that the storm water plan is worth carrying out. If you decide to do such an analysis, be careful. All too often these analyses are attempts to convert costs to specific land owners into costs to the general public. This transfer attempt is done by being fuzzy on who bears the cost and who reaps the benefits implying that the all costs and benefits accrue to the general public. Therefore, if you decide to do a cost benefit analysis of the storm water master plan, be very explicit about who bears the costs and who reaps the benefits. Specifically, list the parcels affected and their owners.
3. As I read the executive summary, this program is going to be funded by monthly fees on our utility bills. If a cost benefit analysis is done, we might find that this program should be funded by specific land owners rather than the public at large. Considering our needs for a jail, earthquake resistant schools, the city general budget short fall, and Corvallis being the most expensive place to live in Oregon, we ought to hesitate before tacking more fees -- taxes -- on to our utility bills.
4. As I remember from the presentation, the short term program extends for the next ten years and the long term program extends from ten years out to twenty years out. The cost estimates are stated in, I assume, current year (2001) dollars. If so, please so state because the dollars for the out year projects will be much higher than the figures in the documentation. The cost estimates seem to be very round numbers indicating that a range is in order -- at least for the larger projects.
5. What is cost of flooding?
6. Mitigation should use a cost/benefit analysis to justify.
7. Who bears costs of policies?
8. Keep cost down.
9. Develop continuum of costs from mandates "Cadillac to PT Cruiser"
10. More overland flow can result in cost savings.
11. Concerned about utility rate impacts.
12. Surprised cost memo to Public Works not included $263,000.00 for one policy!
13. Where will payments come from?
14. Adopting plan before we know cost is a concern.
15. Population not growing at rate to support these alternatives.
16. What is cost of lesser implementation levels, say 90% rather than 100%. May be considerably less $$.
17. Does $250,000,000 include City buying land? Buy early!
18. When did we last have 75-100 year storm? What is $ cost & extent of damage for various storm events?
19. Geographer: cost of damage to community must be compared to cost of protection to decide direction to take
20. How will Bruce get cost under control in next 3 weeks?
21. Look at how much is necessary & who is going to pay for it? We are already the most expensive City. We need more taxpayers? Have to look at economic picture of Corvallis. What if HP changes employment #?
22. The SWPC and City needs to present a more thorough and realistic analysis of the estimated short and long run costs of SWMP to rate payers and to SDC payers. Costs covered by grants and the EPA and DEQ requirements should be identified. In addition, the draft SWMP lacks an adequate summary of benefits accruing from the plan. It would be useful also to provide a rationale for exceeding requirements both in terms of flood control and water quality. I recognize that capital costs are presented in the SWMP. Potential costs of permissive and mandated regulation are not given. I personally do not question the need for an exemplary stormwater abatement system nor costs of such a system but I recognize that a segment of our community wants an explanation for it. In short, the SWMP needs a sensitive public relations framework. To carry through on economic issues will probably delay the Council decision but that is necessary in my opinion.

General Cost Questions/Comments continued:

23. Reviewing page 5-42 of the SWPC draft proposal, I see a very expensive future for the 35,000 full-time residents of Corvallis.

Alternative D - "no structural development within the 100 year floodplain". Allow me to cite two parcels of land located on south 3rd Street and within the 100 year floodplain. The first parcel is immediately north of

Corvallis Rental South and the second parcel fronts on SE Crystal Lake immediately east of Corvallis Rental South. I gather that Alternative D stops all structural development. Should this become law, the two owners of these lands have but one alternative, turn to the citizens of Corvallis for payment ($300,000) of the loss they would suffer from Alternative D or similar laws.

Two routes of collection of the owners loss are available, one Ballot Measure 7 (or its revision) and two, the Right of Eminent Domain. Both of these avenues share the same thesis, "you took the total value of my land",

would say the owners along with countless other landowners, now my fellow citizens of Corvallis, pay me the prior value of my land.

The above draft review is not the invention of the wheel. The US Army Corps of Engineers, in conjunction with the Federal Emergency Management Authority, have done extensive floodplain studies of Corvallis and Benton County. These studies and recommendations are a part of Building and Development Codes of Corvallis. Compliance with the Corps and FEMA recommendations are a prerequisite in issuance of federal flood insurance. These studies carry dates two decades past.

My question is obvious, "we have controls covering structural development within the 100 year floodplain so why incur massive financial liability for the taxpayers of Corvallis by defacto buying the undeveloped land within the 100 year floodplain?

24. I believe that I have a useful perspective from which to comment on the proposed Stormwater Master Plan that is being developed for the city. From 1993 to 1995 I served on a National Academy of Sciences Committee on Flood Control Alternatives in the American River Basin. We produced a book, *Flood Risk Management and the American River Basin: an Evaluation*, published by the National Academy Press in 1995. In that committee experience I got to see first-hand the many sorts of problems caused by inadequate planning, zoning, and preparation for management of stormwater. Of course, the flood risk to Corvallis does not compare to that of Sacramento, but nonetheless the scope of problems is similar.

I attended the public meeting on August 14 and have reviewed in a general way the text of Chapter 5. I believe that the Committee that developed this plan has done an excellent job. They have produced an extremely comprehensive and forward-thinking document that will serve the city well into the future. I am particularly pleased at the watershed perspective of the plan and the way in which it incorporates natural ecological functions into stormwater management. The breadth of concerns addressed by the plan is truly exceptional.

Concerns have been raised about the cost of the plan, and perhaps some additional evaluation is required in that area. However, all around the country there are countless examples where cities and public agencies have looked to short-term economies and ended up paying many times more over the long term. Flood management is certainly one of the most concrete examples of the old adage: "Pay now or pay a lot more later". I strongly support adoption of the proposed City of Corvallis, Stormwater Master Plan.

25. Costs depend on policy being implemented. Yet creating policy requires some idea of proposed costs of policy choices. What can staff do to assist in determining ball park costs for various policies?

26. See memo from Business Advocacy Committee, Corvallis Area Chamber of Commerce dated 7/24/01, "Stormwater Master Plan Cost Estimate".

General Public Process Questions/Comments:

1. Can raw data be placed on web or be more accessible?
2. Some policy work can be by volunteers.
3. Telephone survey based on 360 some residents - small # in 50k town.
4. Flood plain alternative choice - concerned about survey of 30 people for conclusion.
5. Are home owners adjacent to streams aware of these policies that affect them?
6. How can we reach public better? Anyone in audience have ideas?
7. To inform public, language & info are key, keep words to minimum & simple - readable to general public. Put cost on notifications - it gets attention.
8. Are grants available? OWEB?, etc. Adopt-a-stream, private foundations, FM, Ballet Foundation, etc.
9. See memo from Business Advocacy Committee, Corvallis Area Chamber of Commerce dated 7/24/01, "Stormwater Master Plan Cost Estimate".

General Regulatory Questions/Comments:

1. Which of these are required by state and federal mandates?
2. Which are likely to be mandated by the feds and state soon?
3. Which are demonstrated by actual scientific studies to be needed?
4. Which are no more or no less than someone's idealized vision of what could be conceivable in the best of all possible worlds, such as one in which money is not an issue and there isn't a severe shortage of affordable housing?
5. Is SWMP mandated by State or Federal Government?
6. Working with EPA on non-point sources?
7. Request to break policies down into: State & Fed mandate now and State & Fed mandate likely
8. See memo from Business Advocacy Committee, Corvallis Area Chamber of Commerce dated 7/24/01, "Stormwater Master Plan Cost Estimate".

General Questions/Comments:

1. Is there conflict of interest involved in the Chair of the SWPC being the wife of one of the Urban Services Councilors?
2. What is the difference between "bank stabilization" and "channel improvement"? (related to maps)
3. Soils analysis is not specific enough. Soils vary from site to site and affect both run-off as well as ground water recharge. Probably each project needs a separate analysis.
4. Bioswales likely only function as planned if there is a maximum gradient. This needs to be noted at the policy and planning stage. Definition should be amended.
5. I support the Stormwater Master Plan.
6. I would like to express my support for the work of the Storm Water Master Plan Commission. The improvement projects in the local stream basins and the policies developed by the committee will in the long-term, improve habitat for fish and other species, reduce the effect of flooding on our public and private property, and put us in compliance with state and federal regulation. The implementation of these policies will help bring our development code and regulations in alignment with good storm water management practices. I understand there is cost associated with this program but believe the cost to make these changes now will be lower than the cost to fix bad designs later. In fact, some of the policies such as those allowing more pervious surfaces and fewer pipes in our developments will probably reduce first cost. Lastly these policies will integrate well with the Endangered Species response plans and

General Questions/Comments continued:

Natural Features Inventory project to create holistic solutions that will maintain and restore our environment. Our earth provides us with services (clean water and air, fish, habitat) that we do not know how to reproduce at any cost. It is time to take another step forward to insure these services continue to exist for us and our children.

7. I would like to express my support for the work of the Storm Water Master Plan Commission. The improvement projects in the local stream basins and the policies developed by the committee will, in the long-term, improve habitat for fish and other species, reduce the effect of flooding on our public and private property, and put is in compliance with state and federal regulations. The implementation of these policies will help bring our development code and regulations in alignment with good storm water management practices. I understand there is cost associated with this program but believe the cost to make these changes now will be lower than the cost to fix bad designs later. In fact, some of the policies, such as those allowing more pervious surfaces and fewer pipes in our developments, will probably reduce first-cost. Lastly, these policies will integrate well with the Endangered Species Act response plans and the Natural Features Inventory project to create holistic solutions that will maintain and restore our environment. Our earth provides us with services)clean water and air, fish, habitat) that we do not know how to reproduce at any costs. It is time to take another step forward to ensure these services continue to exist for us and our children.

8. I was quite impressed with the quality of work that your team presented. Unfortunately, I have another evening engagement and I was unable to add my comments to the public dialog. For the record, I would like to say "terrific job"! One thing that I enjoyed hearing was the attitude that our city's streams are not ditches but habitat corridors. Additionally, that a few pennies spent today will save the city big money in the future in avoiding erosion and intermittent flooding while improving the quality of life within the city. A very practical goal. As a Corvallis citizen for over 25 years–I'm very proud that our city continually tries to better itself. In closing, please keep up the good work!

9. References to the Natural Features Technical Advisory Committee work should perhaps be made so that the findings of that project could be incorporated into the stormwater management plan.

10. I have attended several NFTAC meetings and the public forum held by the SWPC. At the SWPC public forum things were discussed that were also discussed at the NFTAC meetings. At the SWPC forum I obtained a "project coordination matrix" displaying, amongst other things, the activities of three projects: Significant Natural Features, ESA Salmon Listing Response Plan, and Stormwater Master Plan. Looking at the activities of the three projects, there could be some overlap and duplication. And as a taxpayer, I would hate to pay for an activity more than once. I would hope that you are coordinating your activities and following each other's work very closely. By doing so I would expect that you would learn from each other and not find yourselves in a situation where your notions conflict. Examining the matrix, I would expect the data collection and modeling by the storm water project to be very useful to the other two projects. I would also expect that the review of regulations affecting natural resource management by the storm water project to be useful to the other two projects.

11. I suggest you put documentation supporting your work on the web.

12. I was intrigued by the assumption that the soils, once saturated, act as though they are paved in the before and after development scenarios that were run with the hydrologic models. The soils prior to development have some sort of vegetation (trees, shrubs, grass and herbaceous cover) which intercept rainfall (thus increase evaporation) and can delay runoff travel time across the landscape. Travel time in an urbanized landscape can be changed significantly due to changes in slope by channelizing flow paths, terracing lot areas, leveling depression/storage areas, adding roads, parking areas, and storm sewers. How have the consultants incorporated the removal of vegetation and alteration of flow paths in the hydrologic models? It is well known that the effects of urbanization on a watershed are reduced infiltration and decreased travel time. This results in significantly higher peak rates of runoff. I would think this would be true in the case of larger storm events, as well.

General Questions/Comments continued:

13. Enclosed are copies of tables and charts of basic hydrogeology. Most approaches now recognize the impact of urbanization on land. The premise that because some of the soils are clay and therefore have the same factor for runoff as urbanization, just doesn't agree with the literature (and experience). I am admittedly just on the edge of learning about all there is to know about hydrogeology, but the consultant is suggesting something that is contrary to current thought. The basic equation - runoff = precipitation - (minus) [Etevaporation + ^ Storage] - seems to be the one needed, but where have [ET and ^S] been factored in? Soils are not the only thing to consider when dealing with rain in the open. This is not a simple "pipe" situation. There are many variables that need to be considered - not just soils. Even clay soils are variable and discontinuous, with storage capacity that changes over time. There might be a short period of total saturation - 5 min. to 1 hour, but water is dynamic and in a dynamic system. Evaporation and transpiration are major factors in dealing with stormwater. With urbanization, the native vegetation and therefore root connectivity are disrupted. It is generally accepted that there is considerable storage potential in vegetation - through capture, evaporation and transpiration. Taking the native vegetation out removes storage in the immediate and over time. I hope that you, the consultants and Fred Wright, get together and discuss this in depth. This is information that many people have, not just little ole me. It seems like a difficult position to defend. Besides, it's not ecologically sound.
14. Coordination of ESA, Stormwater Plan & National Resource Inventories is needed
15. How are policies implemented?
16. Don't encourage streets/parking lots in inappropriate place for detention's sake.
17. Bioswales could eliminate large diameter pipe (Venell swale).
18. Check stream flow in SW study area
19. Policy should result in pervious surface parking lots.
20. Concerned that we aren't planning for today's needs.
21. Stream maintenance policy needed
22. How do 1996 rains fit in flood severity?
23. Request to break policies down into: Committee discretion - community values and need for informed decisions from public.
24. How many committee members & employees will be affected? Water forced across his property when 3rd Street worked on - made a dam near his property City will not allow fill - Feds say City responsibility & vice versa (he gets run around) Can't use 3 lots. Is plan from Fed or from citizens on committee? People writing the plan are not affected.
25. Thank you for meetings, used material, web, 2 nights of meetings (first one for orientation)
26. Commend committee, first step in ongoing process:
    - Hydrologic systems complex in urban environment.
    - Provide means to prioritize $, rational basis for cooperative ventures
27. Lived on Dixon Creek for 30 years. Building rock wall (we already have brick terraces) - will unlikely do better job than what's there ($120k / 520)
    - It will damage trees
    - How is this different than 1981 plan?
    - What is Fed, State & optimal?
    - How will this plan change what creek side landowners can do within stream? (remove wood & fallen limbs prevents mosquitos)
    - Cite Fed law, number will assist citizens
28. Flooding development is restricted Fed permits building in floodplain? Why go that far? Part of his property is in floodplain in S. Corvallis.
29. What is most susceptible areas to flooding? Start with those.
30. Need to consider efficiency of bacteria studies.

General Questions/Comments continued:

31. I appreciated being able to participate in the August 16 Open House discussion of the draft Stormwater Master Plan (SWMP). I submit these comments for the record. Particularly, I wish to commend the Stormwater Planning Committee, its Chair and City Public Works Department staff coordinator for the assembling the detailed material representing an incredible amount of hard work. The draft document is a tribute to citizen's role in dealing with complex issues and represents a high level of professionalism. In general, I support the draft plan and hope that the following comments will help improve the document. I support the principle that development should be limited or carefully restricted by code in FEMA floodplain areas. I further support prohibiting development in floodway and 0.2-ft floodway fringe areas. The document of 8/13/01 presenting data for floodplain and floodway fringe lands within the UG. needs clarification. In recent years consensus developed among engineers and resource specialists concerned with flooding that the least expensive and most efficient way of reducing flooding is by <u>non-structural</u> projects such as zoning. Traditional means by dams and river revetments, etc. are regarded today as too expensive. Allowing Oregon's large rivers to occupy the remaining floodplain fragments is becoming more widely accepted in state policy.

32. Modeling stormwater runoff within the City UG. based on soil type, especially on slopes, is a questionable procedure. I am wetlands specialist familiar with the generalization in our soils maps regardless of updating underway. The maps in themselves can not be used to formulate a meaningful policy. I understand that Public Works staff proposed that soils in the Corvallis area are mostly clay and that impacts of development in the short and long run would be negligible. First, slope soils are not mostly clay. Most stream-associated clay-based soils such as the Bashaw Series are confined to the drainage ways, particularly where slopes have a low gradient. Surrounding hillsides often have soils that are more permeable. Many of our floodplains or historic floodplains are dominated by Dayton Series. Second, many of our undeveloped slopes are forested. The role of forest canopy in diminishing runoff is important. With development, there will be increased clearance and increased impervious surface. Both will increase the flashiness of our streams. It is probable that within the short time frame of 10 years there will not be major changes in runoff due to development. However, in a longer time frame of 20 or more years, I do not believe this is a valid projection. I serve as chair of the Benton County Jackson-Frazier Wetland Management Advisory Committee. Although this technical committee appointed by the commissioners has not studied the SWMP, plan policies are of critical concern to our committee. The committee has responsibility for advising the Parks Director in protecting the wetland. Parks Director Jerry Davis submitted written comments to the SWPC summarizing County Park's concerns to which I wish to add some detail. Benton County is mandated by LCC to protect the wetland. Protection extends beyond strict county jurisdiction to the Jackson and Frazier Creek watersheds. Our concerns relate to maintaining the ground water regime, minimizing changes in the surface water hydrograph especially during low flow periods, and maintain water quality.

    Research by David D'Amore and Professor Herb Huddleston (D'Amore et al. 2000) demonstrated the importance of ground water in recharging the wetland. Precipitation enters the watershed soils on slopes and flats and flows downslope in permeable silts about 40 inches below the surface forming an independent hydrological system from the surface water regime. From the standpoint of maintaining the wetland, the stormwater system and its policies should protect the groundwater regime and minimize runoff.

    Surface flow is also important to the biological welfare of the wetland, especially in late spring and early summer. The stream system of combined Jackson and Frazier Creek enters the wetland at a single point at the US 99W bridge. Even the rather sparse development in the watersheds is threatening water input in spring and early summer. We have initiated a surface water hydrological study. Earlier research suggests the wetland has some capacity to reduce down stream flooding in the fall but once the wetland becomes saturated in January, this benefit diminishes.

General Questions/Comments continued:

A study conducted over two years by Crescent Valley High School students under the direction of Bob Madar in 1998 and 1999 showed that dissolved ammonium and nitrate ions and dissolved oxygen collected at nine sample sites in the watershed were lower that EPA acceptable background level (108 samples). Agricultural sites tended to have higher concentrations of nitrate. Nutrient concentrations measured within the wetland were less than in the watershed suggesting that the wetland had a capacity to reduce dissolved pollutant concentrations. While water quality within the watershed is presently in relatively good condition, we are concerned about future deterioration with future development (roads, impervious surfaces and lawn irrigation). It is important for the stormwater system to be able to minimize pollutants in watershed streams.

With respect to Jackson-Frazier Wetland, we recognize a dilemma. While it is advantageous to minimize untreated stormwater flow into streams, it is important to provide that some of this water treated and allowed to infiltrate into the groundwater system as well as be routed into the stream network, especially at lower flows.

33. The North Corvallis Area Plan, now underway by the city, needs to be coordinated with the SWMP and vice versa. The same is true for the South Corvallis Area Plan and West Corvallis Plan completed in recent years.
34. A system of gauging stations and water quality sampling sites needs to be established data collected. A hydrological study conducted within the Corvallis UGB should be initiated. It should be useful in assessing future trends in water quantity and quality in Corvallis.
35. A policy is needed to minimize downstream water flow by paying attention to road orientation.
36. See memo from Business Advocacy Committee, Corvallis Area Chamber of Commerce dated 7/24/01, "Stormwater Master Plan Cost Estimate".

Table 6-4. Dixon Creek Short Term Program

Figure No.	Reach	Recommended Activity and Table 6-3 Observation Reference Number	Capital Cost ($)	Annual O&M ($)	Project Type[1]	Comments
S-1	3rd Street to Railroad tracks	1) Stabilize streambank and provide a more natural stream configuration.	60,000	3,000		
S-2		2) Provide vegetation to improve canopy cover.	2,800	140	Orange line	
S-3		3) Work with ODOT and ODFW to address fish passage issues at Highway 99.	1,920	360		
S-4	Railroad tracks to 9th Street	1) Provide plantings on south side of stream to increase shading.	3,200	160		
S-5		2) Stabilize streambank and provide a more natural stream configuration.	14,000	700	Green line	
S-6	9th Street to Buchanan Avenue	1) Monitor streambank and house elevations.	NA	250	☑	
S-7		2) Create a slot in the concrete cap of the sanitary sewer downstream of 11th Street to reduce water surface elevation of water backing up behind blockage or provide stream channel improvements to allow fish to pass blockage.	2,000	360		
S-8		3) Work with high school to modify groundskeeping and create buffer strip along stream.	1,920	NA		
S-9		4) Improve riparian area through establishment of native vegetation as part of streambank stabilization projects.	12,000	600		
S-10		5) Replace demolition debris downstream of 10th Street with vegetative streambank stabilization.	30,000	1,500	Green line	
S-11		6) Stabilize streambank and provide a more natural stream configuration.	7,000	350	Yellow line	
S-12		7) Remove sediment upstream of 9th Street and monitor to determine source.	NA	250		
S-13		9) Replace undersized pipes along Buchanan Avenue, Kings Boulevard, and Grant Avenue.	757,000	NA	Red line	
S-14	Buchanan Avenue to Grant Avenue	2) Remove obstruction near 15th Street and Lincoln Avenue.	5,000	NA		
S-15	Grant Avenue to Garfield Avenue	1) Monitor stream levels at 13th Street and Greeley Avenue to determine extent and duration of reported flooding.	NA	750	☑	
S-16		2) Monitor stream levels at Vista Place (near 15th and Grant) to confirm success of flood mitigation project.	NA	750	☑	
S-17	Garfield Avenue to Kings Boulevard	1) Monitor stream levels at Arthur Circle to confirm success of flood mitigation project.	NA	750	☑	
S-18	Kings Boulevard to Circle Boulevard	4) Construct multi-use riparian facility to provide water quality/detention benefits in cooperation with the school district.	226,000	2,260		
S-19	Circle Boulevard to 29th Street	4) Monitor situation to determine if pinch point near 29th Street is contributing to local flooding problems.	NA	750	☑	
S-20		5) Remove encroaching structures, widen channel, and install rock walls where necessary to increase channel cross-section and capacity.	120,000	6,000	Yellow line	1. Recommendations not necessary. Be cost efficient. Could the resources be spend towards people impacted by flooding?

Table 6-5. Dixon Creek Long Term Program

Figure No.	Reach	Recommended activity and Table 6-3 observation reference number	Capital cost ($)	Annual O&M ($)	Project type[1]	Comments
L-1	Willamette River to 3rd Street	1) Stabilize streambank slopes using matting and vegetation.	28,000	1,400	Green line	
L-2		2) Adjust culvert elevations to address fish passage and stagnant pool issues or install low flow culvert.	17,000	1,700		
L-3	Railroad tracks to 9th Street	3) Install structural stormwater treatment facilities to treat water from Avery Square parking lot.	20,000	2,200		
L-4	9th Street to Buchanan Avenue	3) Install structural stormwater treatment facilities to treat runoff from high school.	15,000	1,650		
L-5		8) Install end of pipe technology for treating stormwater from Buchanan Avenue.	15,000	1,650		
L-6	Buchanan Avenue to Grant Avenue	1) Coordinate with private property owners on stream restoration to stabilize streambanks.	2,400	180	Green line	
L-7		3) Coordinate with private property owners to improve habitat.	1,200	NA		
L-8		4) Remove sediment from culvert at Buchanan Avenue and monitor to determine source.	NA	275		
L-9	Grant Avenue to Garfield Avenue	3) Improve riparian area with native plantings throughout reach.	21,000	1,050		
L-10	Garfield Avenue to Kings Boulevard	2) Extend habitat upstream of Porter Park by placement of large wood debris.	6,000	300		
L-11		3) Replace undersized pipe along Kings Boulevard and install end of pipe technology for treating storm water.	158,000	1,650	Red line	
L-12	Kings Boulevard to Circle Boulevard	1) Replace undersized pipe along Circle Boulevard and install end of pipe technology for treating storm water.	106,000	1,650	Red line	
L-13		2) Remove sediment from culvert at Circle Boulevard and monitor effectiveness of upstream erosion controls.	NA	275		
L-14	Circle Boulevard to 29th Street	2) Stabilize streambanks with log cribs and vegetative techniques where walls not required.	7,000	350	Green line	
L-15		3) Improve culverts at 27th Street to allow fish passage past blockage.	3,800	190		
L-16	Walnut Boulevard to Headwaters (West Branch)	4) Stabilize channel along Glenridge Drive using vegetative means.	49,000	2,450	Green line	
		Total	**449,400**	**16,970**		

[1]Project types are found in the Figure 6-4 map legend.

NA = Not applicable

General Comments/Questions:

1. Dam shouldn't be allowed at Circle Boulevard.
2. More interested in cost effective improvement that are required rather than selective.

Table 8-4. Jackson-Frazier-Village Green Creeks Short-term Program

Figure No.	Reach	Recommended Activity	Capital Cost ($)	Annual O&M ($)	Project Type[1]	Comments
S-1	Sequoia Confluence to Conifer Blvd	1) Plant trees at top of bank for shade.	22,000	NA	Orange line	
S-2		2) As part of a comprehensive analysis of stream corridor issues, including Jackson-Frazier Wetlands hydraulics, determine extent of flooding and ways to deal with source of blockages.	30,000	NA		
S-3	Conifer Blvd to Jackson-Frazier Wetland	1) Plant trees/shrubs as part of community involvement program. Use dense or thorny shrubs or other ground cover to limit heavy foot traffic in eroded areas.	2,100	100	Orange line	
S-4	Jackson-Frazier Wetlands	1) Coordinate with County and OSU studies to determine storage potential and flow regime of wetland, especially flow split between Village Green and drainage ditch to northeast. Coordinate with Jackson-Frazier Friends group.	19,200	NA		
S-5	Jackson-Frazier Wetlands to Highland Drive (Jackson Creek)	1) Establish conservation easements with willing property owners	4,000	NA		
S-6		2) Remove non-native vegetation, widen stream and stabilize with willow plantings. Work in conjunction with long-term Projects.	60,000	3,000		1. Coordinate with GLT, JF Advisory group. It is the site of an enhancement project. 2. Conflict restoration effort from OWEB – coordinate with Greenbelt Land Trust and Jackson-Frazier Wetland Advisory Committee.
S-7	Crescent Valley HS (Highland Drive to Crescent Valley Drive-Jackson Creek)	1) Reroute water pipe along roadway.	28,000	NA		
S-8		2) Community stewardship opportunity to work with school to remove non-native invasive species like blackberry and ivy.	400	NA		
S-9		3) Call potential flooding problem to school's attention.	200	NA		
S-10		4) Coordinate with school district to install end of pipe treatment before discharge to stream from parking lots and cut back pipe to allow vegetative treatment for playing field underdrains.	800	NA		
S-11	Crescent Valley Drive to McDonald State Forest (Jackson Creek)	1) Develop conservation easements/ stewardship programs in conjunction with property owners and county.	4,000	NA		
S-12		2) Work with county to confirm hydraulic analysis of the replacement bridge at Crescent Valley Drive.	800	NA		
S-13	Jackson Creek Headwaters (McDonald State Forest)	1) Coordinate with Oregon State University Forestry Department and other property owners.	800	NA		
S-14	Highway 99 to Highland Drive (Frazier Creek)	1) Develop conservation easements/ stewardship programs in conjunction with property owners and county.	4,000	NA		

Table 8-5. Jackson-Frazier-Village Green Creeks General Comments:

1. I would like to go on record in support of the draft Stormwater Master Plan. The Benton County Parks Department is responsible for the management of Jackson-Frazier Wetland. Much of the Jackson-Frazier Wetland watershed is in the City urban fringe and therefore,.a successful Stormwater Master Plan is of critical interest to us. The draft Plan submitted by the Stormwater Master Plan Commission will provide the mechanism to improve fish habitat, reduce the effect of flooding and lesson non-point pollution impacts on public resources such as the Jackson-Frazier Wetland. The Jackson-Frazier Wetland Technical Advisory Committee, and many community volunteers, are committed to managing the Wetland resource for its intrinsic values. The current draft Plan submitted by the Stormwater Master Plan Commission provides the policies necessary to assist our efforts in managing for a healthy functioning Jackson-Frazier Wetland. Thank you for allowing me the opportunity to give input on this important planning document.

Table 9-5. Sequoia Creek Long-term Program

Figure No.	Reach	Recommended Activity	Capital Cost ($)	Annual O&M ($)	Project Type[1]	Comments
L-1	Highway 99W to Highland Drive	1) Determine if undersized pipes along Highland Drive need to be replaced after the downstream capacity is increased.	166,000	NA	≋	
L-2		2) Coordinate with ODOT to remove existing berm located between two ditches and replace culverts along Highway 99 to increase carrying capacity of channels.	75,000	3,750	≋	
L-3		3) Lay back the streambank to improve flow regime and provide for greater flood storage.	120,000	6,000	≋	
L-4	Walnut Boulevard to Headwaters (North Branch)	1) Provide channel and stream improvements to control erosion near Sundance Circle where streambed or streambank have not already been armored with riprap.	35,000	1,750	Green line	1. Infested with blackberries and metal debris. Told it was going to be dredged. When?
L-5		2) Raise elevation of Chipmunk Place and Antelope Place to continue to allow ponding behind culvert without flooding road.	25,000	NA	≋	
L-6		3) Increase storage capacity of channel directly upstream of Chipmunk Place and Antelope Place culverts.	40,000	2,000	≋	
	Total		**461,000**	**13,500**		

NA – Not applicable
[1]Project types are found in the Figure 9-4 map legend.

General Comments/Questions:

1. Sequoia Creek along Sequoia Avenue overgrown with brush and debris, needs work!
2. Why does Sequoia Creek (on the map) stop at Highland? There is a significant ½ mile channel and 2-3 acre wetland upstream of Highland Drive. Developer of Highland Dell Estates put large dam structure and water control structure in channel. Is this currently allowed?

Table 13-4. South Corvallis Long-term Program

Figure No.	Reach	Recommended Activity	Capital Cost ($)	Annual O&M ($)	Project Type[1]	Comments
L-1	Goodnight Avenue Basin	3) Investigate sale to trailer court.	2,000	NA		
L-2	Millrace Basin – Evanite Culvert to Highway 99	4) Stabilize banks with structures along banks that also provide habitat value.	63,000	3,150	Green line	
L-3		6) Anchor large woody debris in channel to improve habitat and stabilize channel bottom.	20,000	1,000		
L-4	Millrace Basin – Highway 99 to Allen Street	6) Stabilize banks with structures that also provide habitat value.	70,000	3,500	Green line	
L-5		8) Anchor large woody debris in channel to improve habitat and stabilize channel bottom.	12,000	600		
L-6	Millrace Basin – Allen Street to Marys River	3) Work with Benton County to stabilize with structures that also provide habitat value. These can be worked in with large woody debris already in this stream reach.	2,000	NA	Green line	
L-7		4) Conduct feasibility study to identify regulatory (environmental and water rights) and engineering issues with reconnection of the Millrace to Marys River.	30,000	NA		
	Total		**199,000**	**8,250**		

[1]Project types are found in the Figure 13-5 map legend.
NA=Not Applicable

General Questions/Comments:

1. Chapter 13 of the SWMP assumes that the SCDMP will be implemented for the future scenario. We are asking that some wording be added to Chapter 13 which will allow some flexibility in design specifically for the property discussed above. It is our intention that the principals of both the SCDMP and the SWMP would be followed, but we would like to have the option of draining this property to the north and ultimately to the Mary's River, should it be practical to do so. The topography of this area naturally slopes to the north and northwest. If this area could be drained to the north, it would help limit the impacts on Dry Creek, a stated goal of the SCDMP, and it would reduce the size of the water quality feature needed in service area 7. This would help to reduce the potential of attracting birds to the airport vicinity which is also a concern in the SCDMP. The SCDMP contemplates some flexibility in design for service areas 1 through 6. We believe that flexibility should also be extended to service area 7.
2. Missing Ryan Creek on map.
3. Foundation collapsing south of Alexander in former Ryan Creek because natural drainage was not respected.

EXCERPTS OF MEETING MINUTES
URBAN SERVICES COMMITTEE
AUGUST 14, 2001

Bob Stebbins stated that he and his neighbors on SW Brooklane Drive (Brooklane) have practical experience with flood water, noting that at times he has left his house via canoe because the street to the north was six feet under water. He explained that Brooklane extends along the top of a ridge between the Marys River and a branch of Squaw Creek. He expects that the area soils are present because they are dense clay, otherwise they would have eroded during earlier flooding events. He referenced Water Quantity Management Policy QN-2. He said the driveway and parking area in front of his house are level and drops only a few inches from the street. He recently installed a manufactured house on his property; City staff determined there was insufficient drop to drain storm water to the street and approved installing a storm water drainage pipe to the nearby floodplain. During the past five or six years, he has watched the storm water on his property, which seeps into the soil before it reaches the end of the four-inch perforated pipe he installed to the floodplain. He added that the soil on his property is clay and observed that clay holds more water than sand but absorbs water more slowly. His adjacent property has an asphalt driveway that always had a puddle during heavy rain events. He drilled a hole in the center of the puddle, installed a four-inch pipe, topped the pipe with screen, and held the pipe in place with gravel and an asphalt patch. He now rarely has a puddle in the driveway. His neighbor has a level gravel driveway, which drains during heavy rain events. He questioned the appropriateness of smaller lots with large houses and driveways that have only small landscaped areas of pervious surfaces. He said establishment of codes that require impervious surfaces create water quantity problems because the only place for the water to escape is via the storm sewer system. He noted that placing landscape cloth under gravel keeps the gravel from sinking into the dirt, so the ground continues to drain. He said the First Congregational Church was told that, if it repaves the parking lot, the storm water must drain into the storm sewer. He noted that a small stream on the property drains to Squaw Creek. He expects that drainage from the parking lot during a heavy rain event would double the volume of the stream, which he doubts will pass through the culvert. He considered it "silly" to have a code requiring management of excess storm water runoff.

Liz Frenkel said she looked at all the maps on display and observed a green line representing stream bank stabilization. In some cases the stabilization actions are listed as short-term projects, while, in other cases, they are listed as long-term projects. She said the action apparently involves riprap but could have different types of alternatives. She inquired about the criteria for determining short-term and long-term projects.

Scott Mater said he grew up with the flooding events along Brooklane. He concurred with Mr. Stebbins regarding the issues of soil capacity and impervious lot coverage. He said he had not seen indication of the actual costs of flooding events in terms of the floodplain, but not water quality. He inquired about the cost of damage as a result of flooding. He suggested that the USC and the SWPC consider a cost-benefit analysis regarding floodplain mitigation. He believes the 1996 flood would have been worse, if not for flood controls installed by the United States Army Corps of Engineers in the Willamette and Columbia Basins. Before the City spends money, he suggested discussion of a cost-benefit analysis and what is being mitigated by pursuing the activities proposed in the SWMP. He referenced Floodplain Management Policies FP-4 FP-8 and said he did not see in the policies an indication that they addressed only small or large streams. He suggested that, if Policy FP-4 is intended only for small stream basins, it should so state.

John Detweiler suggested that the first action should involve determining the cost of the proposed activities and who would pay for them. He said he attended two recent meetings of the Natural Features Technical Advisory Committee (NFTAC). He noted that the SWPC and the NFTAC seemed to address many similar issues.

Bruce Hecht said it seemed that many of the proposed SWMP policies must be implemented in the LDC. He inquired how the different plans will be implemented.

Dave Steele inquired whether the SWMP was mandated by the State or Federal Government.

Tom Jensen referenced questions in the alternatives workshops questionnaire regarding using streets and parking lots for water detention and retention. He noted that this issue was addressed in Water Quantity Management Policy QN-1. He said he did not want the idea of using streets and parking lots for water detention and retention to be construed as an invitation for construction in these areas. He requested clarification of Uplands Natural Resource and Wetlands Management Policy UP-8 and the phrase "other wetland functions outweighing lost functions." He believes that all functions are necessary. He referenced Stream System Management Policy SS-5i and inquired whether the phrase "large wood" meant logging. Removing fallen trees would remove the natural environment. He observed that all new development must be plumped into the storm drain. The City collects fees for the water using storm drains. He inquired how this policy would affect the City's revenue. He questioned whether a citizen who developed a "grey water" system would receive a break on their utility bill.

Mr. Jensen observed that the policy implies that the City would not mitigate lost wetland if the remaining wetland has a more important function.

Councilor Butcher suggested indicating on the SWMP continuum what is mandated, what is an ideal situation, and where the proposed activities will take the community. She expects that not doing so will cause the City to encounter further concerns from citizens.

Joan Noyce said she gathered information concerning storm water, including information from Bellevue, Washington, which developed a SWMP during the 1970s. The Bellevue plan began similarly to the Corvallis plan and incorporated all three of the issues questioned. Bellevue found that, besides protecting streams and the city, it was more cost effective to have overland flow from streams, adding that it is very expensive to install pipes, curbs, and gutters. Bellevue experienced significant savings by implementing a stream protection program that had more overland flow than the proposed Corvallis plan.

Don Herbert referenced the South Corvallis Drainage Master Plan and inquired whether the SWMP could include a policy to eliminate large pipes and put water into bioswales for treatment. He believes that this procedure could help and would provide opportunity to eliminate the Venell Swale. He suggested that staff review the parcel north of Airport Road between the railroad tracks and Oregon State Highway 99 West in the Southwest Study Area. He said the study has the flow moving south; it currently flows north. He said it may be better to include the property in the Northwest Study Area.

Lyle Brown questioned the quality of the data gathered during the surveys and inventories and inquired whether the data could be made available for public review in terms of the bases for decisions regarding the SWMP.

Scott Mater referenced Uplands Natural Resource and Wetlands Management Policy UP-8 and noted that the policy does not define the term "basin." He stated that the Corvallis community is within the larger Willamette River Basin. He noted that the policy should define the size of a basin. He added that other details should be given similar treatment.

Bruce Hecht suggested that a great deal of the proposed policy activities could be accomplished by volunteers, noting many volunteers available through the Corvallis Environmental Center. He added that the SWMP presented a large opportunity for volunteers to be involved in the community. He reiterated the comment regarding impervious surfaces. He noted that his friends wanted to develop a restaurant without a paved parking lot; the LDC did not allow this type of development, but the proposed SWMP would allow the development at a lower cost. Ms. Benner verified that Mr. Hecht was referencing Water Quantity Management Policy QN-2c.

Don Brown expressed disappointment that more homeowners from the floodplains were not in attendance. He said he did not see any mention in the policies concerning maintaining streams in the immediate future. He said $400,000 was spent on Dixon Creek. He does not see that the SWMP addresses planning for the immediate future. He was a Corvallis resident during the 1964, 1996, and 1997 floods. He stated that Dixon Creek did not flood during 1964 but did flood during 1996 and 1997. As a senior citizen, he is concerned that the City is discussing increasing wastewater fees, which seem to continue increasing. He contended that senior citizens cannot afford to flush toilets in Corvallis because of the City's wastewater fees.

Al Bown inquired whether staff intended that building on hills would not significantly change runoff. He inquired whether anyone conducted infiltration studies on the surrounding hills to determine the rate at which water percolates through the soil. He asked if estimates were calculated regarding the amount of water that will flow down Dixon Creek as a result of the new construction on the ridge.

Mr. Bown inquired whether the differences in soils were studied and the amount of water each soil type holds.

Dave Steele inquired how far water backed up in Dixon Creek from the Willamette River during the 1996 flood event.

Donna Schmitz referenced the Cross-Jurisdictional Basin Storm Water Management policies and inquired about the timeline for working with Benton County concerning developing a basin-wide storm water management program and how it relates to the urban fringe boundary.

Don Herbert inquired whether staff reviewed whether, during a major storm event, releasing water early is more advantageous than releasing it late. He asked whether it was better to release storm water early while waiting for storm water from Blodgett and Fall Creek to enter the storm water system.

Marge Stevens referenced the Cross-Jurisdictional Basin Storm Water Management policies and inquired whether these policies would include working with the EPA concerning non-point source pollution runoff.

EXCERPTS OF MEETING MINUTES
URBAN SERVICES COMMITTEE
AUGUST 16, 2001

George Mears inquired, from a benchmark perspective, where the 1996 and 1997 floods would be considered in relation to the floodplains. Mr. Moser responded that the 1996 rainfall event was recorded as a 25-year event. He noted that, during a two-year period, the community experienced four storms classified as greater than ten-year events and two storms classified as greater than 25-year events. The February 1996 storm involved rain falling on frozen slopes at elevations above 800 to 1,000 feet. This created a runoff greater than would have been expected from the rainfall event. He noted that, in terms of scale, the community has experienced some very large flood events. He was not aware of similar events during the 20 years preceding the 1996 flood.

Mary Nolan referenced the issue of costs. She expressed surprise that the July 3rd memorandum from Public Works staff to the USC was not included in the material made available to the public. She said Public Works staff performed an order-of-magnitude estimate for the SWMP. One of the floodplain management policies had an estimated cost of $263 million. She commented that the cost of the policy is so large that it will probably not be effectively implemented and, thus, should not be included. She said the SWPC was asked to classify the recommendations according to current State or Federal mandate, anticipated State or Federal mandate, community need demonstrated through scientific evidence, and those recommended at the discretion of the SWPC. She said she did not believe anyone could make an informed comment about the recommended policies without the classification breakdown. She added that the request was made July 3rd and later.

Karen Steele inquired as to the source of the funds for the projects.

Carlyn Roy referenced Chapter 5 of the SWMP and expressed concern about basing public opinion on the survey responses of 366 residents in a town of 50,000 people. She observed that the City was considering adopting a plan prior to know the cost of its implementation. She referenced page 542 of the draft plan concerning floodplains and noted alternatives "a" through "d" concerning construction in the floodplain. She said 30 participants rated the alternatives and favored more restrictive alternatives. She expressed concern about polling the citizens, rather than following the opinions of 30 citizens. While the City is facing budgetary shortfalls and the school district is closing schools and addressing budget issues, she believes the City must prioritize projects for the next two years. She expressed hope that the SWPC, the USC, and the Council will take these facts into consideration. She believes the population is not growing at a pace that can support some of the proposed projects.

Ms. Roy noted that many Corvallis residents are affected by the SWMP, particularly in the more-populated areas. She inquired whether the residents were asked about how they would be affected by the plan.

Stan McCall stated that he owns property on SE Bridgeway Avenue. He said the mill race was change during 1987 to develop the property along Third Street; this forced water across his property. In accordance with City permits, he filled his property during 1979 to create building sites. The property is still four inches too low, but the City will not allow him to add four inches of fill. He consulted Federal agencies, which told him that the City has authority to change the mill race and not allow him to fill his property. City staff have told him that they must follow Federal rules. He questioned whether the SWMP was required by State and Federal regulations.

Mr. McCall inquired whether the entire SWMP was required by Federal regulations or merely desired by the City and the SWPC.

Chaun MacQueen inquired whether anyone could suggest a better means of reaching the public. She said she is an education outreach specialist for the Benton Soil and Water Conservation District.

Liz Frenkel said she knew the SWMP was underway for some time, but she did not spend time investigating the actions related to the plan. She attended the August 14th USC/SWPC meeting, reviewed the basin maps and recommendations, and researched the internet. She thanked the USC and the SWPC for conducting the meetings this week and noted that she would submit her written comments and questions. She added that the meetings provided her an opportunity to learn about the plan.

Larry Earhart said he presumed that the estimated $263 million cost represented investment to achieve no loss in the 100-year floodplain. He believes it would be more relevant and effective to consider the cost to prevent 90 percent of anticipated flood-related damage. He expects that $10 million invested in projects would resolve 90 percent of anticipated flood-related loss. He would prefer a lower cost figure to prevent a lower percentage of flood-related loss.

Bob Frenkel said he appreciated the Committee presenting tonight's forum and seeing citizens involved in the SWMP development process. He commended the SWPC for development of the SWMP, which he observed is the first step in a continuing process. He commented that many of the concerns expressed today address the problem as though the SWMP were the last step in the process. He noted that the SWMP represented an in-depth analysis of the complexities of hydrological systems in the urban environment and provides a means of prioritizing capital improvement funds, which could not be done without an analysis. The plan also provides a means of mitigating damage to property and the City and maintaining the integrity of a natural resource system. The plan provides a rational basis for cooperative ventures between the City, Benton County, the development community, and citizens. He added that he serves as Chair of the Jackson Frazier Wetland Advisory Committee and looks forward to preparing detailed written comments for the Committee's consideration. He thanked the USC and the SWPC for conducting the forum.

A member of the audience questioned whether the $263 million in recommendations includes necessary land purchases, citing Floodplain Management Policy FP4-42d; if so, he believes the City would own a lot of worthless land to prevent construction of structures in the floodplain.

Karen Steele stated that her family lived on Dixon Creek for 30 years and did a lot of work themselves on the creek bank. She said part of the plan includes $120,000 to build a rock wall. Residents along the creek have brick terraces on their properties, and passersby consider the terraces structurally sound and attractive. She questioned how building a rock wall would save her house or anything downstream during a 100-year flood, speculating that it would not do a better job than what the area residents have already constructed. She said the riprap on one side of the creek has been overgrown by ivy, which helps hold soil in place. Along the creek bank are large cottonwood and ash trees, the roots of which would be damaged by construction of a rock wall, resulting in possible removal of the trees; she questioned who would pay for the work. She inquired how the proposed SWMP differs from the 1981 DMP. She said she did not see anything indicating what components of the proposed SWMP are new, were in existence, or are being updated; she added that she would like to see a comparison of the two plans. She would also like to know what aspects of the proposed SWMP are required by Federal or State regulations and what aspects are options. She asked how the proposed SWMP affects current plans and construction in terms of what can be done along the creek. The current instructions do not follow any guidelines that contribute to good creek maintenance. She noted that many limbs fell into the creek during a wind storm last night; she said leaving the limbs in the water will result in "dead" water, creating an environment for mosquitos. She clarified that the $120,000 project was indicated in Stream System Policy SS-20 for Dixon Creek.

Ms. Steele acknowledged Ms. Benner's comments but suggested including State or Federal legal citations to assist citizens in researching the regulations.

<u>Stan McCall</u> said the SWMP did not contain an indication about the floodway, but it does mention the floodplain. He said the Federal government permits construction in the floodplain. He inquired why the City changed its policy to prohibit building in the floodplain.

Mr. McCall noted that South Corvallis flooded four times during 42 years. Ms. Benner suggested that Mr. McCall review the floodplain alternatives and determine if one better meets his perspective. Mr. McCall said his property is in the floodplain and the floodway.

<u>Mary Nolan</u> observed that informing the public and making them aware of what is happening involves, as key factors, language and presentation. She suggested attending marketing classes. If notices are written in technical jargon, they will be understood only by people who know the jargon. Associating cost estimates with notifications will get public attention.

<u>Bob Frenkel</u> referenced the costs of flood damage associated with building into the floodplain and the more deadly floodway. He suggested that the only way to evaluate the costs to the community is to compare them with the costs of protection. He said this was why many of the laws were mandated by the Federal government, noting the national recognition that it is often cheaper to deal with protection projects.

An audience member referenced the Council beginning the review process in three weeks and inquired how staff would refine costs during the three-week period.

An audience member suggested that the SWPC, the USC, the Planning Commission, and the Council should determine how much of the SWMP is really necessary and who will pay for it. He referenced a recent study that named Corvallis as having the highest cost of living in the state. He believes the local tax base is suffering and schools are being closed because no one can afford to live in Corvallis. He does not expect that more people will become residents of Corvallis if costs are increased. He observed that the proposed SWMP will be expensive to implement and must be paid for by taxpayers.

Chaun MacQueen inquired whether the City could obtain grant funding to help offset the costs paid by local residents. MacQueen suggested private resources.

Dave Steele stressed the need to review the economic picture of Corvallis. He expressed concern if Hewlett-Packard lays off employees and how such action would impact the City's tax base.

An audience member inquired which area of Corvallis is most susceptible for flooding and whether there were plans to address that area first.

APPENDIX B
STREAMWALK SUMMARY

Dixon Creek
South Fork Squaw Creek
Lower Squaw Creek
Lower Sequoia Creek
Oak Creek

Watershed: DIXON CREEK

Date: November 1997

Location: West Tributary to North Fork

Observations: The small segment of creek most directly affected consists of approximately 300 feet of channel immediately upstream of Arrowood Circle just north of Sitka Place. The channel traverses set-aside open space (a community commons) within a suburban residential development in this headwaters area of the creek. Ownership is unknown. The channel is within a broad draw, has a generally very steep gradient, is 2-3 feet wide, 12-18 inches deep, and is intermittent.

The stream nearly disappears as a discrete watercourse in the upper part of the draw, especially where gradient locally flattens. Downstream, the channel becomes increasingly steep and more and more deeply entrenched as the road (Arrowood Circle) is approached. This results in exceptionally steep (>1:1) and essentially bare sideslopes which are many feet high. The terrain here at this lower end of the subject reach is man-made and surface soils appear to consist largely of sterile subsoils. These slopes at the lower end are therefore subject to chronic surface water erosion and are too steep and sterile to support ground-covering vegetation (without an exceptionally serious planting effort). The lower parts of the convex sideslopes here are too steep to ever support vegetation.

According to Patricia Benner, this area has incised and headcut to a considerable degree over the last several very wet winters and all appearances suggests that this is in fact the case. Channel degradation no doubt occurred because future channel adjustments accompanying alteration of the catchment's hydrology were not considered and planned for during site development. The trajectory (although not the rate) of channel adjustment in this area was perfectly predictable before development. That is, discharging more water into a high gradient channel traversing erodible material than the amount to which it was previously adjusted <u>will</u> result in channel degradation.

Apparently as a response to channel incision, a local property owner has lined the channel with angular rubble rock. Rock along the bank is now becoming stranded as the streambed degrades. The rock in the channel bed can only exacerbate a tendency for future lateral channel adjustments (i.e. widening). If left to its own devices, this segment of the creek will continue to be a chronic sediment source and, increasingly, an eyesore in this landscaped commons. This little stream unfortunately serves as an unequivocal and highly visible model of inappropriate channel management in the urban setting, especially in valuable open space areas.

Recommendations: Relatively minor channel bank regrading over most of the reach, a serious replanting effort, and the installation of appropriately placed, naturalistic grade control structures (otherwise known as channel-spanning sills, weirs or "check dams") would prevent further channel degradation and soil erosion in this area. Based on Todd's experience in these settings, large boulder sills tend to be simpler to build and more trouble-free than log sills. The very steep, deeply entrenched banks on the lowermost stream segment would need a low retaining wall structure integrated into the channel reconstruction. This could probably be either in the form of a hand-stacked stone treatment or a more naturalistic "boulder-strewn" bank.

All plantable surfaces should be amended with organic matter to improve the soil's tilth and productivity. Attractive native species, many of which are used as landscape ornamentals anyway (e.g. vine maple, kinnickinnik, Oregon grape) can be planted in such a way as to preserve the view of this little creek channel for the neighbors. Mowing requirements would be reduced and people strolling the adjacent asphalt path would gain aesthetic and sensory benefits from the many small, noisy "waterfalls" now forming the watercourse.

Stewardship Opportunities: Most (and potentially all) of this project could be completed by community volunteers. The project scale is small enough and there would be no issues related to inwater work during the summer months. Small mobile landscape equipment, such as Bobcats, can potentially be operated by volunteers and can easily access the site without damage to property. Rock sills and retaining walls can be constructed with untrained manual labor (supervised) in this very small creek and of course volunteers could accomplish all the soil amendment and planting tasks. After a careful design is provided, the cost for equipment and supplies, including large stock plantings, is likely to be quite small (provisionally estimated at less than $7500.00).

Location: North Fork Dixon Creek, existing pond (Hidden Pond) immediately upstream of Walnut Boulevard.

Observations: Pond infilling with sediment; concrete outlet structure beginning to fail; potential source of thermal pollution (due to the large surface area of standing water and shallow depth) and chemical pollution (due to contamination by waterfowl excrement) to mainstem Dixon Creek; controlled water surface limits flood storage potential.

Recommendations: Remove the pond and outlet structure and re-create a naturalistic low-flow channel through the area. This would create a large in-line flood storage facility with considerable freeboard. The area would also sequester sediments (from continuing construction and/or poor management practices upstream) on the constructed floodplain. This could reduce sediment supply (and therefore channel-filling deposition) in the low-gradient, flood-prone area of Dixon Creek downstream. As an added measure, a sediment forebay and engineered channel cleanout area could potentially be installed on the upstream side of Walnut Boulevard. (Fish would not appear to be an issue because of the Walnut Boulevard culvert and very limited fish potential upstream.)

Location: Timberhill at Creek Tributary to Dixon Creek, Timber Hill Park immediately upstream of Walnut Boulevard.

Observations: Park appears under-utilized park at present; grass turf extends to channel margin; a major park activity appears to be dog walking, resulting in potential animal waste discharge to creek (no intervening buffer); moderate inchannel condition and poor riparian zone condition.

Recommendations: Regrade and replant the park (left) side of the creek to create a functional buffer; possible opportunity to retrofit (with extensive excavation) for meaningful flood storage, benefitting the flood-prone portion of Dixon Creek downstream. A sediment forebay and engineered channel cleanout could potentially be installed on the upstream side of Walnut Boulevard in conjunction with this work. (Fish would not appear to be an issue because of the Walnut Boulevard culvert and very limited fish potential upstream.)

Location: Near Walnut Place

Observations: A residential structure (deck?) has been placed over the channel just downstream of the Walnut Place crossing. This represents undesirable infrastructure encroachment on the floodway and poses a hazard during floods. (The view of this structure was obscured by blackberry thickets.)

Location: Substation and Hoover School to Northwest Baptist Church Site

Observations: Stream is deeply to moderately entrenched and moderately confined by infrastructure, with significant areas of riparian open space. Cover is mainly either a rank growth of grasses or mowed lawn, with substantial areas of blackberry. The channel is deeply incised near the Hoover School and substation, with many mature alder trees rooted low along the channel. Erosion on the steepest banks here (1:1) are experiencing some erosion, exacerbated by the low-rooted trees, which act as hard points and locally concentrate scour. A sewer crossing in this vicinity has been uncovered by channel incision. The concrete cap over the pipe has been partly removed, leaving the pipe exposed.

Extensive and broad channel-marginal flood benches occur in the vicinity of Northwest Baptist Church, suggesting recent incision into an area of former alluviation. This area is maintained and mowed for recreational use. Overhead cover is generally good and is afforded mainly by alder.

Overall instream and riparian habitat quality is low throughout this entire reach. The overall trajectory of channel change in the area is stream degradation (channel incision and widening). This is evidenced by exhumed rooted tree trunks in the active channel, suspended outfalls, laterally undercut tree roots, bank failures, and toppling trees. This reach is now a chronic sediment source for Dixon Creek.

Recommendations: Regrade and replant streambanks and install naturalistic and fish passable channel grade control structures. A large area (+5 acres) of open space, which is likely used only seasonally, in the vicinity of the Baptist Church site affords an opportunity to retrofit for significant flood storage in this area. A passive flood storage facility could be designed which enhances natural features and recreational use of the area during the non-flood season. <u>Constraint</u>: Private ownership.

Toppling trees present potential debris jam and bank erosion sites since the trees are likely to fall during a flood. To eliminate this hazard, the trees at risk can be removed, leaving the rooted stumps in place. The exposed sewerline upstream should be stabilized by recaping and installing grade control structures and channel marginal treatments to prevent further channel incision or widening.

Location: Northwest Baptist Church to 29th Street

Observations: Stream is channelized, deeply to moderately entrenched, and highly confined by mainly residential development. Banks along the lower reach appear generally stable, with extensive blackberry and ivy cover. Narrow flood benches marginal to the low-flow channel are common. Overhead cover is good (mainly alder), although overall instream and riparian habitat quality is low. Substrate is largely gravel and soft bedrock, with silt-floored backwater pools. There is evidence of beaver activity in this area.

Recommendations: Closely-spaced mature alders form a significant channel pinch point not far upstream of 29th Street. To eliminate this hazard, the lower bank trees can be selectively removed, leaving the rooted stumps in place.

Location: 29th Street to 27th Street

Observations: Stream channelized, deeply entrenched, and highly confined by residential development. Significant sections of lower bank have been revetted with stacked demolition debris (broken up concrete pieces). Non-protected banks appear generally stable because of cohesive bank materials, although significant bare upper bank areas occur which are subject to chronic but apparently low levels of erosion by scour or surface wash. Overhead canopy coverage is moderate, although some of these trees are rooted along the low-flow channel, creating a potential conveyance issue. Overall instream and riparian habitat quality is low. Substrate is largely gravel and bedrock. Fish passage is hampered at the 29th Street box culverts.

There is a stacked log/timber pile revetment of creosoted logs along the outside bend approximately 100 feet downstream of 29th Street. (Creosote-treated logs are not considered appropriate for the small waterway environment.)

Recommendations: The timber pile revetment structure is presently being undercut by high stream flows and should be watched for future instability. Alternatively, the structure could be preemptively replaced to provide a more durable, environmentally-appropriate structure associated with upper bank riparian revegetation.

Location: 27th Street to Elmwood Drive

Observations: Stream channelized, deeply entrenched, and highly confined by residential development. Extensive lengths of channel-confining bank revetments are present, especially along the right bank. These include high walls of stacked timbers, salvaged concrete pieces or stone. Unprotected banks appear generally stable because of cohesive bank materials and dense vegetation (mainly weedy blackberry and ivy). Overhead canopy cover is generally good. Overall instream and riparian habitat quality is low. Substrate is sand, gravel, soft bedrock. Fish passage is hampered at the 27th box Street culverts.

The breached remnant of a concrete low-head dam was identified at approximately 100 feet downstream of the 27th Street crossing. This was causing accelerated bank erosion. The dam was removed by the City in 1998.

Location: Elmwood Drive to Circle Boulevard

Observations: Stream channelized, moderately to deeply entrenched, and moderately confined by residential development. Banks are largely unprotected by revetments, although as few homemade lower bank treatments are present. Streambank angles vary from very steep to relatively low, with the banks appearing to be generally stable because of cohesive composition and extensive vegetation cover (mainly blackberry and ivy). Grass-covered flood benches occur, with some of these forming significant undercut banks. Overhead canopy cover is moderately good considering the small channel size, although overall instream and riparian habitat quality is low. Substrate is silt/sand/gravel. Extensive gravel bars were noted in the upper part of this reach. The Elmwood Drive box culverts were partially clogged with sediment deposits in November of 1997.

Recommendations: A small concrete stop log structure just upstream of Circle Boulevard creates a pinch point for a potential debris jam. Damming the creek here is inappropriate and removing this structure will relieve this hazard.

Location: Circle Boulevard to Kings Boulevard (Jefferson Elementary School)

Observations: Stream is moderately entrenched with no confinement by developed infrastructure along the right (south) bank; a parking area closely encroaches on the north bank. The school property along the right bank appears to be under-utilized, consisting of the maintained playground most distant from the school buildings and a large, infrequently-mowed vacant area to the west of this. Relatively recent enhancement plantings have supplemented mature alders on the south bank, resulting canopy coverage of the channel which should impove over time. Low flood benches with undercut banks are extensive along this reach, producing overhead cover and somewhat improved aquatic habitat compared to many other reaches. Overall instream and riparian habitat conditions must still be considered degraded. The prevalence of these low flood benches creates a narrow two-stage flood cross-section, mimicking a natural floodplain where overbank areas absorb much of the energy of high stream flows. Substrate is silt/sand/gravel. Channel bank and beds appear essentially stable. The Circle Boulevard twin box culverts were partially blocked by sand and gravel deposits in November of 1997.

Recommendations: This large area of under-utilized, publicly-owned open space immediately adjacent to the stream provides a potentially valuable opportunity to create a relatively large passive flood storage facility. This can be a true multi-objective urban stream rehabilitation project, with habitat, recreational, and visual improvements readily integrated into the flood alleviation design. The standard prescription would be to excavate a large area adjacent to the channel to greatly enlarge functional floodplain area.

Stewardship Opportunities: Enhancement work here affords obvious educational/volunteer opportunities.

Location: Kings Boulevard to Beca Avenue

Observations: This area was enhanced for improved drainage in 1997. The work consisted mainly of streambank regrading to enlarge the flood conveyance cross section and the installation of bypass pipes at road crossings. Upper bank planting of native riparian trees will eventually provide overhead cover, improving the thermal regime of the creek.

Recommendations: The left (north) bank just downstream of Kings Boulevard began failing (due mainly to mass wasting processes, not fluvial erosion) in the winter of the 1997-98. This area was at the upstream end of (and primarily upstream of) the previously described streambank work. Watershed Applications analyzed the site and recommended a planted log cribwall treatment along this section of bank. This was installed by the City in the fall of 1998.

Location: Beca Avenue to Buchanan Avenue

Observations: Moderate entrenchment and moderate to low confinement by residential development. Banks through most of the reach are stable, although there are substantial areas of fresh bank erosion from recent floods. Bank cover angle varies from near-vertical (at failures) to quite shallow and bank cover varies from bare to grass to extensive areas of blackberry thicket. Glide and backwater pool habitat predominate (forced by riffles comprised of rubble and demolition debris or soft bedrock knickpoints). Substrate is primarily silt and sand. Overhead canopy cover is generally good, with this provided largely by ornamental plants and conifers. Overall instream and riparian habitat quality is low. Yard debris dumping along the channel margin is common.

Recommendations: On the left (east) bank upstream of Buchanan Avenue there is a large area of apparently under-utilized streamside property which could potentially be used to create an off-channel flood storage site. Constraint: Probable private ownership.

On the left bank just downstream of the junction of 15th Street and Lincoln Avenue there is bank erosion; grass to channel edge, and no native riparian buffer. A low dry stone retaining wall could be constructed along the bank toe. The upper bank could be regraded and planted with native riparian vegetation. Minor boulder grade controls could be installed to support the dry stone wall revetment.

Location: Buchanan Avenue to 11th Street (Corvallis High School)

Observations: Stream channelized, moderately entrenched, and moderately confined by school infrastructure. Banks are largely unrevetted, although there is a dumped rock riprap treatment at the bend just downstream of the Buchanan Avenue bridge. Localized bank failures are common and there is a partially slumped bank on the right channel margin about 200 feet downstream of

Buchanan Avenue. Downstream of this, an old outfall structure forms a hard point, with a small area of bank erosion immediately downstream. Tension cracks are common along the right bank just upstream of 11th Street. Bank vegetation is mainly weedy grasses and canopy cover is almost non-existent. Stream habitat in this low-gradient reach consists mainly of glide habitat formed by a backwater condition generated well downstream of 11th Street (see below). Fine-grained substrate predominates. Instream habitat and riparian zone conditions are uniformly poor. There was a large deposit of sediment under the Buchanan Avenue bridge in 1997.

Recommendations: Multi-objective rehabilitation project for bank stabilization, improved conveyance and bank storage, improved stream habitat, enhanced amenity value, and educational opportunities. This can be accomplished by regrading and replanting streambanks, creating a stable channel margin, and creation of a two-stage channel cross section (by the excavation of low, channel margin flood benches) in the long but relatively wide reach between opposing school buildings. Additional work could include adding a curb to the parking lot on the right bank and directing storm runoff through a stepped grassy swale instead of through the pipe now discharging directly to the creek. Enhancement work here affords obvious educational/volunteer opportunities.

Location: 11th Street to 10th Street

Observations: Stream channelized, moderately entrenched, and highly confined by residential development. Banks are largely non-revetted but appears relatively stable because of cohesive bank materials and blackberry and ivy vegetation cover. Overhead canopy coverage is good, with a large component supplied by non-native horticultural species (especially English laurel). Overall instream and riparian habitat quality is low. Substrate is largely silt. A 12-inch diameter steel pipe and rubble cover forms a low weir with a 1.5-foot drop about 125 feet downstream of 11th Avenue. This creates the long backwater extending upstream through the Corvallis High School reach. This weir/ramp also creates a long plunge pool below the structure. Sediment and vegetation-covered dumped riprap treatments up- and downstream of the 10th Street bridge restrict conveyance in this area.

Location: 10th Street to 9th Street

Observations: Stream channelized, deeply entrenched, and highly confined by both residential and commercial development. Banks are largely covered with a rank growth of non-native grasses or (especially) with dense blackberry thickets. Although banks appear to be mainly stable (because of cohesive bank materials and vegetative cover, the dense blackberry cover may be hiding bank failures: streambanks appear to be quite steep in these areas. Some of the turf-covered banks also appear to be deeply undercut and may be prone to localized failure. The left (outside) bank of the tight bend below 10th Street is revetted with dumped demolition debris and has an associated scour pool; the right (outside) bank of the tight bend upstream of 9th Street is turf-covered and is progressively failing as localized sloughs. Overhead canopy coverage is very poor and overall instream and riparian habitat quality is low. Substrate is unknown (most of the channel was inaccessible on the survey date) but is suspected to be dominated fine sediment accumulations because of low channel gradient: grade control at the 9th Street crossing creates a long backwater up through this reach.

Location: 9th Street to Reiman Avenue

Observations: Stream channelized, deeply entrenched, and highly confined by commercial development. The left bank is covered by a rank growth of non-native herbaceous weeds which appears to be periodically treated by cutting or herbicides. The slope angle here is about 2:1; the right bank is very steep (1:1) and covered with a similar but thin growth which appears to reflect poor soil conditions (gravelly silty clay). There are a few slump failures on this oversteepened right bank. Overhead canopy coverage is nil and overall instream and riparian habitat quality is extremely poor. Native herbaceous wetland species such as rushes and sedges (e.g. <u>Scirpus</u> sp.) occur along the channel bottom along with reed canarygrass and other weedy graminoids. The streambed consists mainly of gravel and rubble with vegetation-stabilized fine sediment deposits along the margins.

Recommendations: Regrade banks to lower angles (requiring widening of the easement and some removal of asphalt) or create low stone breast walls to allow lower angle plantable surfaces within the existing easement. Amend soils and replant banks (especially the south bank) with native riparian vegetation, including fast-growing species such as alders. Capture/treat parking lot runoff if feasible.

Location: Reiman Avenue to Railroad Tracks (end of survey)

Observations: Stream likely channelized but has begun to reinstate a sinuous alignment. The channel is deeply entrenched, however, and some relatively extensive bank failures have occurred here. Significant bank erosion is evident on the right bank just downstream of the Reiman Avenue crossing. This is both exacerbated by and evidenced by a poured concrete spillway draining a facility pad, which is now deeply undercut. The property is undeveloped so is presently mostly unconfined by infrastructure (especially on the right bank downstream of the light industrial facility (with the drain) near Reiman Avenue. The streambed varies from sand and gravel to coarse rubble, with shallow glide/pool habitat and intervening rubble riffles. Banks are steep but are widely separated, providing for a narrow but low, functional floodplain of both depositional and streamcut surfaces. Bank cover is largely non-native grasses with minor blackberry thickets and some native woody vegetation.

Recommendations: Variably regrade banks to lower angles to create plantable surfaces along the channel margin. Amend soils and replant banks (especially the south bank) with native riparian vegetation, including fast-growing species such as alders. Special emphasis should be given to preserving as much existing woody vegetation on the site as possible, including the large specimen oak at the top of the bank near the railroad tracks. Naturalistic grade control structures may be required, but these can also provide instream habitat and visual interest. rol and habitat. This project, in a site yet to be developed, could serve as a model for the preemptive rehabilitation of urban infill sites.

Watershed: SOUTH FORK SQUAW CREEK

Date: December 1997

Location: 500 Feet of Stream Corridor Immediately Upstream of 53rd Street

Observations: The City requested that this area be evaluated because it was slated for future development. The stream and floodplain in this area consists of a wide, continuous riparian corridor of ash and hawthorn trees with considerable channel-spanning downed woody debris (mostly smaller material). The channel is not incised and the floodplain is essentially unconstrained and hydrologically connected to the channel. There is no significant channel bed or bank erosion. There is a wide strip of ash woodland on the north side of the creek, with the likelihood that there are pockets of wetland in this area, although most of the floodplain area away from the channel does not appear to be jurisdictional wetland. These conditions make for a relatively diverse habitat area, with good restoration potential. Canopy coverage is good and riparian and instream habitat value can be described as moderate. Good channel/floodplain coupling suggest that much of the site is prone to flooding under high flow conditions.

Recommendations: As a condition for any development, require wide streamside buffer strips for the purpose of providing flood protection and wildlife habitat, in addition to the maintenance of channel shading.

Location: Straightened Reach Downstream of Technology Loop (600 Feet)

Observations: Stable but lacks visual interest and habitat value could be improved.

Recommendations: The wide set-aside buffer area between the creek and the multi-unit housing complex on the right bank affords the opportunity to enhance this area as a model for both habitat and visual improvement. The creek could be at least partially re-meandered through this reach at relatively low cost (minimal earth movement required because the channel is not entrenched). Existing volunteer woody vegetation could be supplemented with limited plantings (using volunteer regrowth in the rehabilitation strategy). Structural habitat for both terrestrial (riparian) and aquatic species could be improved with the addition of salvaged downed woody debris. Much of this work could be done at low cost by community volunteers.

Location: Sunset Park, North of the Existing Baseball Fields (1100 feet of channel distance, within a corridor width of 200-400 feet)

Observations: The channel is not incised and the floodplain is unconstrained through this large area, which includes significant amounts of native woody vegetation. Portions of the channel are lined with ash. The grassy swards and patches between woodland areas are presently mowed but these lawn areas provide no wildlife habitat. Nor do they provide an area for human use because of persistent wetness (much of this seasonally wet area appears to be jurisdictional wetland).

Recommendations: his substantial area of publicly-owned open space affords the opportunity to implement a large, multi-functional stream corridor rehabilitation project at relatively low cost. One way this could be done is by excavating multiple anastomosing (interconnecting) channels in the area. Relatively low cost is assured because the channel is not incised within its floodplain. In conjunction with grading, additional native riparian and wetland trees and shrubs, as well as large woody debris accumulations, could be installed throughout the area. This work could potentially occur over several years and be conducted by community volunteers. Ultimately, a low-impact boardwalk system could be routed through a portion of the renaturalized area. Such a treatment would provide 1) some level of flood storage (through both an increase in capacity and enhanced floodplain roughness), 2) water quality improvement by the filtering of overbank flows and shading in now sunny channel locations , 3) enhanced wildlife habitat, 4) enhanced amenity and passive recreational opportunities. (Note that these alterations may require an upgrade of the culverts under Country Club Place since the road crossing is quite low.)

Location: Country Club Place Downstream, South Side of Channel (500 feet of channel distance)

Observations: The lower part of this undeveloped area is quite wet (may be jurisdictional wetland) and the entire area appears to be abandoned pasture or hay meadow. The area is now growing into thickets of native rose and ash saplings with swards of buttercup and rush in the wettest areas. The area is now traversed by several small, fast-flowing drainage ditches, which appear to originate (at least in part) from the golf course uphill of Country Club Drive. Thus, untreated but potentially contaminated runoff is discharged directly to Squaw Creek.

Recommendations: Additional flood storage could be provided in this area by mass excavation. A low-cost alternate project would be to de-channelize at least the lower ends of the ditches, allowing the water to spread out over the toeslope wetland before reaching the creek. Constructing earthen, log or rock sills along the slope contour would enhance this effect. Water spreading in this area would provide water quality filtering of the golf course runoff before it reaches Squaw Creek. It would also provide a small (but incremental) amount of runoff detention, contributing to reduced flood peaks. This work could conceivably be accomplished entirely by manual labor at almost no cost (a good volunteer activity).

Location: Starker Arts Park Pond

Observations: High waterfowl use of this pond contaminates the water draining from the pond directly to the creek.

Recommendations: Convert the "100 foot long earthen ditch between the pond outlet and the creek into a broad vegetated bioswale with numerous log or rock sill drop structures.

Stewardship Opportunities: All of this work could potentially be accomplished by community volunteers.

Location: Downstream Of 35th Street at John Adams School (600 feet along the north side of the channel)

Observations: A considerable width of mowed grass in this streamside zone is apparently little used by the school because it is remote from school facilities and is persistently wet for most of the year.

Recommendations: Excavate a flood storage facility along the north side of Squaw Creek on John Adams School property. Re-meandering the straightened creek channel through this reach could be a part of this work but is not mandatory. Tree and shrub plantings would be used to create a riparian fringe to the off-channel flood storage area; wetland plantings could be installed within the facility. In addition to being already owned public open space, the site affords obvious educational/volunteer opportunities.

Complimentary work on the right (south) bank of the creek through this same reach could be accomplished on adjacent private property (church). Mowed grass on this property continues to the channel edge, which is over-steep and failing in places. There is sufficient space available to regrade the banks along the church property and install a functional woody riparian buffer here. At least one storm drain discharging from this property could potentially be daylighted and routed through a naturalized bioswale for stormwater pre-treatment. Constraint: Private ownership.

Location: Stream Corridor Several Hundred Feet Up- and Downstream of the Knollbrook Place Bridge.

Observations: Stream is not entrenched, generally only slightly incised (but becoming more incised at the downstream end), and only moderately confined by residential development (relatively wide setbacks). There is a narrow functional floodplain which is colonized by in its upper part by weedy grasses but is joined along the lower part by relatively extensive stands of hydrophytic forbs such as sedges and buttercup (Ranunculus). Canopy coverage is moderate (interrupted young stands of native riparian trees and shrubs along the south bank). Streambanks are silt/clay, with minimal bank erosion. Problem: Minor street flooding in this area.

Recommendations: Additional flood storage and improved habitat and aesthetic conditions could be provided in this area by relatively small-scale excavation to enlarge the floodplain area (accentuate the two-stage cross section). Machine access is good for this work. The opportunity for this especially good upstream of the bridge, and especially on the north side of the creek. Minor channel re-meandering could easily be incorporated within this work, at relatively low cost. Additional woody vegetation plantings, especially on the south bank, would improve canopy cover.

Watershed: **LOWER SQUAW CREEK**

Date: 1999

Location: Entrenched Meanders Downstream of Knollbrook Place

Observations: Squaw Creek begins to develop more sinuosity downstream of the channelized reach in the vicinity of Knollbrook Place. On the other hand, the straightened channel segment at Knollbrook Place at least possesses a partially functional floodplain while the stream become progressively more entrenched and de-coupled from its floodplain below this area. A private road servicing a few homes bordering the tight meanders of the creek on wooden bridges at two locations. This dead-end road extends west from Brooklane Drive. Bank erosion is occurring locally in the vicinity of these two bridges.

The channel in the area with a strongly meandering pattern is generally entrenched to a depth of 4-8 feet. Active channel width in this area averages about 10-12 feet, although there are some areas where the channel is narrower. Streambanks are generally very steep (often near vertical) but largely stable, being comprised primarily of clay. Very little woody debris occurs below the mean water surface elevation because the channel through most of this area has a chute-like aspect, with smooth clay banks. Most of the fine- to moderate-sized woody debris (including some larger logs) found within this reach is stranded on the flat above the channel and is well out of reach of ordinary stream flows. These woody materials provide no instream habitat whatsoever and thus the active channel itself exhibits low overall habitat complexity.

The streambed through this reach generally consists of clay, although demolition debris has fallen into the channel from homemade revetments and rubble rock has fallen into or been placed within the channel in places, such as around the bridges. Much of this very low-gradient reach consists of a long stretch of slackwater glide which is as much as 3-4 feet deep and in which flow is barely perceptible during low-water conditions. Some of this backwater is attributable to debris jams which partly block the channel. The roughly poured concrete apron around the westernmost private automobile bridge also forces a long backwater pool.

Much of the creek in this reach is bordered by dense blackberry thickets, although there is an overstory of larger ash, oak, maple and alder trees in the central part of the area. The understory here includes blackberry as well as a number of native shrubs, such as snowberry, serviceberry, oceanspray, hawthorn, Pacific ninebark and hazel.

Willow is locally abundant along the uppermost part of this reach. In this area, willow branches extend well below the top of bank. Minor floated debris accumulations were found throughout this reach when evaluated in August of 1999. This is partly because the willow branches tend to capture flood-borne debris.

There was a prominent debris accumulation which fully spanned the channel in the vicinity of the Reed Place cul-de-sac. Fish passage through this area under low-flow conditions was impossible. The dam was formed from sediment, demolition rubble, and fine to coarse woody debris and has apparently persisted for some time because it had a willow sapling rooted in it. The top of the dam was about 2 feet above streambed grade. This deposit not only fragments aquatic habitat but is causing accelerated bank erosion in its vicinity. In a few other areas, large root structures also pinch down and entirely block the low-flow channel.

Along healthy, un-incised streams, such low slung branches generally provide healthy riparian habitat. In contrast, neither the branches or their accumulated debris was within the ordinarily flooded portion of the channel cross section within this entrenched channel. In a few places, some moderately-sized branches and racked-up wood pieces nearly penetrate the water surface but these provide only minimal instream cover. Because of the stream's entrenched condition, this material also tends to cause local channel erosion. Successive accumulations such as this may contribute to local backwater flooding in the vicinity of Knollbrook Place.

One apparently private water pump was also noted on this reach of Squaw Creek. The pump appeared operational and is probably used for domestic irrigation. Many such private pumps on small urban streams are not a permitted use.

Recommendations: Minor pruning of the overhanging willow branches along a portion of this reach could reduce the tendency for debris jams to occur here and perhaps alleviating flood impacts somewhat in the residential area upstream. Selective pruning of only the lowest branches would not impact habitat conditions because their removal will not affect channel shading or damage the plants. Very little of the debris hung up on these branches extends into the ordinarily wetted channel perimeter but is instead left suspended above the wetted channel after flood recession. This captured debris (and the living branches that cause this) do not provide instream structural habitat because the debris is mostly fairly fine and perishable, because it is transient (passing through during floods), and because even the larger wood pieces are only rarely in the water.

More permanent flood relief in the Knollbrook area might be achieved with some sort of high flow bypass through this area. Because stream gradient is low in this area, the resistance to flow imparted by the meander bends must form some component of the flooding in areas upstream. Such a high-flow bypass channel would not effect ordinary flows and could be enhanced as a habitat area within the riparian zone.

Location: Confluence with Marys River Through Channelized Reach

Observations: The confluence of Squaw Creek with the Mary's River at Brooklane Drive is impassable to fish in the absence of very high Mary's River flows backwatering up into this area. There is a ±4 foot high concrete weir with a vertical face and no plunge pool (just angular boulders) immediately downstream of the Brookland Drive bridge and flow goes subsurface in the steep, rock-filled channel from the weir downstream.

Squaw Creek makes a sharp turn immediately upstream of the bridge. This bend is fully revetted with quarried rock rip rap. The stream has a nearly straight alignment for hundreds of feet upstream of this bend, having been channelized at some point in the past. This straightened and re-aligned reach still retains a generally trapezoidal cross section and is entrenched about 8-12 feet below the surrounding terrain. Channel gradient is low and streambanks appear to consist mainly of silty clay, making them relatively resistant to erosion.

Confinement due to entrenchment as well as episodes of sediment deposition within this reach has resulted in the formation of sporadic low flood benches only a few feet wide within this reach. This provides some incipient sinuosity to the low-flow channel in this otherwise straight channel segment. The low flood benches are stabilized by alien grasses (especially reed canarygrass) and mainly weedy forbs, such as creeping buttercup. Active channel width is about 10-12 feet but the low-flow channel is often considerably narrower than this because of the accreted benches. Where the channel bottom could be observed, it consisted of basalt boulders and rubble with heavy silt deposits. This suggests that the channel was lined with rock when it was constructed.

The bank slopes above the low-flow channel are at an angle of 1:1 or somewhat shallower and support mainly dense blackberry thickets which are penetrated here and there by relatively immature individuals of native woody riparian species, including alder, ash, oak, maple and willow. However, these plants grow densely enough and are mature enough to provide moderately good shade to the channel, except in the reed canarygrass-dominated section just upstream of Brooklane Drive.

Floated tree limbs and medium-size woody debris, along with a few small logs, form occasional accumulations within this channelized reach, caught up in the limbs of brushy vegetation growing along the lower banks. These cause local bank erosion within this confined channel while at the same time providing some insteram habitat diversity. The presence of the flood benches also creates a deeper low-flow water column than would have been present just after channelization, thereby improving both stream temperature conditions and instream habitat. Nevertheless, channel habitat conditions must still be regarded as degraded, with poor opportunities for fish to hold in this reach during higher stream flows.

The general habitat conditions described above continue up through the broad bend and subsequent short straight reach just below the "outlet" of the entrenched meanders (see below). However, tree growth becomes more mature in the upstream area (creating a more "tunnel-like", shaded channel). The left (outside) bank in this area has been revetted with dumped rock and concrete demolition debris. A channel-spanning debris dam was located in August of 1999 in this area (about 250 feet downstream of the easternmost private automobile bridge; see below). The deposit consisted of both sediment and small to medium-sized woody debris and formed a fish impassable barrier at this location. This deposit apparently resulted from the accumulation of flood-borne debris on a very low, sweeping willow trunk which partly blocks the channel here. The dam stood about 4 feet high above streambed grade.

Recommendations: In terms of immediate priority, the small debris jam just discussed should be removed unless higher seasonal streamflows have already done this. However, the structure appeared stout enough that it may persist through the high-flow period.

The entire designated reach down to the Brooklane Drive bridge is essentially free of encroaching infrastructure, making functional restoration in this area technically straightforward. The undeveloped stream corridor width through this reach is generally on the order of several hundred feet. This would allow extensive bank slope reprofiling and functional floodplain re-creation along with stream re-meandering. Structural habitat improvements for instream cover could readily be built into the channel at this time. However, upstream development suggests fine sediment delivery would remain an issue in this reach insofar as instream habitat conditions are concerned.

Confinement due to entrenchment as well as episodes of sediment deposition within this reach has resulted in the formation of sporadic low flood benches only a few feet wide within this reach. This provides some incipient sinuosity to the low-flow channel in this otherwise straight channel segment. The low flood benches are stabilized by alien grasses (especially reed canarygrass) and mainly weedy forbs, such as creeping buttercup. Active channel width is about 10-12 feet but the low-flow channel is often considerably narrower than this because of the accreted benches. Where the channel bottom could be observed, it consisted of basalt boulders and rubble with heavy silt deposits. This suggests that the channel was lined with rock when it was constructed.

The bank slopes above the low-flow channel are at an angle of 1:1 or somewhat shallower and support mainly dense blackberry thickets which are penetrated here and there by relatively immature individuals of native woody riparian species, including alder, ash, oak, maple and willow. However, these plants grow densely enough and are mature enough to provide moderately good shade to the channel, except in the reed canarygrass-dominated section just upstream of Brooklane Drive.

Floated tree limbs and medium-size woody debris, along with a few small logs, form occasional accumulations within this channelized reach, caught up in the limbs of brushy vegetation growing along the lower banks. These cause local bank erosion within this confined channel while at the same time providing some insteram habitat diversity. The presence of the flood benches also creates a deeper low-flow water column than would have been present just after channelization, thereby improving both stream temperature conditions and instream habitat. Nevertheless, channel habitat conditions must still be regarded as degraded, with poor opportunities for fish to hold in this reach during higher stream flows.

The general habitat conditions described above continue up through the broad bend and subsequent short straight reach just below the "outlet" of the entrenched meanders (see below). However, tree growth becomes more mature in the upstream area (creating a more "tunnel-like", shaded channel). The left (outside) bank in this area has been revetted with dumped rock and concrete demolition debris. A channel-spanning debris dam was located in August of 1999 in this area (about 250 feet downstream of the easternmost private automobile bridge; see below). The deposit consisted of both sediment and small to medium-sized woody debris and formed a fish impassable barrier at this location. This deposit apparently resulted from the accumulation of flood-borne debris on a very low, sweeping willow trunk which partly blocks the channel here. The dam stood about 4 feet high above streambed grade.

Recommendations: In terms of immediate priority, the small debris jam just discussed should be removed unless higher seasonal streamflows have already done this. However, the structure appeared stout enough that it may persist through the high-flow period.

The entire designated reach down to the Brooklane Drive bridge is essentially free of encroaching infrastructure, making functional restoration in this area technically straightforward. The undeveloped stream corridor width through this reach is generally on the order of several hundred feet. This would allow extensive bank slope reprofiling and functional floodplain re-creation along with stream re-meandering. Structural habitat improvements for instream cover could readily be built into the channel at this time. However, upstream development suggests fine sediment delivery would remain an issue in this reach insofar as instream habitat conditions are concerned.

A more restrained channel rehabilitation approach is also possible in this reach. This might entail removing the blackberry thickets, lowering bank angle to some degree (but preserving the native woody vegetation wherever feasible), accentuating the "apparent" sinuosity of the stream by widening the existing flood benches in a staggered pattern from bank to bank (while preserving a narrow low-flow channel), and replanting native tree and shrub vegetation along the upper bank slope. This could create a well-shaded but more open creek corridor in this reach. Structural habitat improvements to the low-flow channel could also be installed as a part of this more restrained approach.

of these properties could be appropriated without completely eliminating the backyards, assuming the residents are willing participants.

Wherever feasible, Todd suggests regrading bank slopes to a lower angle than was possible on Dixon Creek. This should increase groundcover and tree planting success and minimize the risk of localized slope failures in the future. A number of the properties, especially those which front on Sycamore Avenue, have very deep backyards so this may be feasible in much of the area.

It would be useful to maintain or construct a narrow low-flow channel (3-4 ft wide or so) to assist in temperature modulation and the improvement of (at least seasonally-available) aquatic habitat. This can be done by preserving existing depositional flood benches, and creating new flood benches when cutting back the banks, as was done on Dixon Creek. As an optional treatment, in areas where the channel currently has a wide, "flat" floor, low channel-pinching benches could be constructed by creating a stable perimeter of large rock or coconut fiber logs, backfilling these structures, then stabilizing these surfaces with seed and matting, or with pre-grown turves (sod mats). Areas of excess fine sediment accumulation, such as upstream of small debris jams and in the vicinity of the major pipe outlet near Trinity Missionary Church, should be cleaned out as part of the channel rehabilitation work.

If there is interest in it, bank regrading and (possible) low-flow channel reconstruction could be conducted in a manner that disguises the straightness of the channel. Making the new bank slope contours sinuous, and shifting the low-flow channel from side to side with flood benches (constructed or preserved), would impart a more natural appearance to the channel. This would improve the aesthetics of this reach considerably. On the other hand, there may be no need for this extra effort since it is not a public access area.

Beneficial trees growing along the upper portion of the bank (south bank in particular) might be retained wherever feasible so as to not completely eliminate the shade canopy from the creek corridor. Hand-stacked stone retaining walls or riprap can be placed adjacent to preserved trees where slopes cannot be laid back if this option is chosen. Todd has applied this technique with success on several projects.

As recommended for Dixon Creek, aggressive tree planting should be applied to upper regraded bank slopes and the top of bank, leaving the lower bank open for conveyance purposes. Trees should be preferentially planted on the south bank if budget is limited. Recommended species include, but are not necessarily limited to, alder, Oregon ash, bigleaf maple and white oak. Cottonwood seedlings and saplings growing within the low-flow channel should be eliminated as they will eventually interfere with flow conveyance.

Finally, it might be useful to construct sediment traps or forebays where major pipes outlet to the open channel of Sequoia Creek (i.e. Highland Drive and the major left bank outlet situated just downstream from Fairlawn Street). These could be constructed for periodic easy cleanout by heavy machinery.

Stewardship Opportunities: Tree planting and maintenance to insure successful plant establishment.

Watershed: LOWER SEQUOIA CREEK

Date: April 28 and 29, 1998

Location: Highland Drive to 9th Street

Observations: This segment of Sequoia Creek in the Corvallis lowlands is completely channelized and undoubtedly bears little relationship to the original Sequoia Creek drainageway. The channel appears as a straightline ditch which is formed in cohesive silt/clay material, is entrenched about 6-8 feet below the regional grade, and has a very low gradient. Low-flow channel width varies from about 3 feet (where low depositional flood benches are present) to 12 feet. The streambed consists of silt or fine sandy sediment, with occasional very loose, deep deposits of this material. There are also occasional channel-blocking accumulations of man-made debris (tires, lumber, etc.) and smaller woody debris in the low-flow channel. Banks are generally stable and in most places are covered with weedy grasses or forbs, or blackberry thickets. The woody vegetation canopy is interrupted in places but trees or shrubs generally occur on at least one bank over most of the length of the corridor. Trees and large shrubs range from seedlings to mature individuals of cottonwood, willow, alder, hawthorn, *Prunus* sp. (e.g., cherry) and occasional ornamentals such as exotic conifers.

At Bruce Moser's request, Todd looked for a pipe outfall on the left (north) bank which appears on City maps generally in line with Fairlawn Street. Todd was unable to locate this outfall because the bank in this vicinity was covered with a blackberry thicket. However, there was no obvious evidence of a functional outfall in this vicinity, such as a locally eroded bank.

A major pipe feeds into Sequoia Creek on the left bank about 150 feet east of Fairlawn Street (and just west of the Trinity Missionary Church). The outlet consists of a broad concrete arch, the roof of which is about 4-½ feet above the streambed, which consists of silt and fine sand. Channel invert width is about 15 feet. The homeowner immediately upstream reports that small children walk along the top of this outlet structure, which is crossed by a fence (leaving only a narrow edge on which to walk). He is concerned for their safety. The hinged steel grate gate on the structure was found open during the April 28 field visit.

Because the stream is extensively piped upstream of this area, and because it goes dry in the summer, it is our opinion that instream habitat conditions (which are very poor) should not greatly influence channel management decisions with respect to flood relief on this segment of the creek. Todd's discussion with Gary Galovich of the Oregon Department of Fish and Wildlife (and a member of the SWPC) back in early March suggested that the ODFW would likely concur that this system has low rehabilitation potential with respect to fishes, especially salmonids.

The City has indicated that this segment of the creek is extremely flood prone and they would like to see some rehabilitation work done here this year. We agree and believe that the stream corridor environment in this reach can be benefitted by an appropriate flood improvement project in this area.

Recommendations: The obvious approach to improving flood conveyance here is to enlarge the floodway cross section, as was done last year on Dixon Creek. The stream corridor is closely encroached upon by backyard fences, leaving an "average" corridor width on the order of 30-40 feet. However, the backyards of the residences along the creek are generally fairly deep so a segment

Location: 9th Street to Highway 99W

Observations: A large quantity of fine sediment has accumulated in the three box culverts under 9th Street. The straight reach between 9th Street and Highway 99W is hemmed in by commercial parking lots and has a highly simplified cross section with a 12-foot wide silt-floored streambed and steep (~1:1) bank slopes. There is no hindrance to conveyance through this reach but curb-to-curb stream corridor width is only about 30 feet. Moreover, flow conveyance is retarded by the sharp left bend taken by the channel when it reaches the vicinity of Highway 99W as well as by the double channel configuration (with intervening soil berm) of the segment extending north along the highway, downstream of this tight bend.

Recommendations: Clean out the sediment under and in the vicinity of the 9th Street crossing. Conveyance through the straight reach between the two roads could be enhanced if the corridor width could be enlarged, allowing bank slopes to be reprofiled to a lower angle. Alternatively, retaining walls and a low flood bench could be constructed to create an enlarged cross section within the existing stream corridor width, although this would probably be expensive and may not be necessary if other potential flood conveyance improvements are implemented. It would have the advantage, however, of being a highly visible improvement. (Also, it would be a chance to demonstrate that there are "hard" or "engineered" but still environmentally-sensitive stream corridor rehabilitation treatments appropriate to, and often necessary in, highly urbanized environments – a "bioengineering" approach is not realistic on many urban stream segments.) The ornamental shrub hedge on the right bank could be replaced with native trees and shrubs for improved shade and some degree of "re-naturalization."

We agree that the double-channeled segment of Sequoia Creek paralleling Highway 99W should be rehabilitated by eliminating one of the channels and removing the high, steep soil berm between the two channels. Material from the berm can be used to fill the redundant channel. A broad, low flood bench and increased flood channel conveyance capacity would thereby be created. Extensive tree plantings on both sides of the channel would shade the channel and flood bench, eventually reducing flow-retarding grass and shrub growth in the lower floodway cross section. As an added measure, the right bank at the tight bend, where the creek turns north along the highway, could potentially be excavated into an "alcove" which would promote sedimentation in this area. This could be easily accessed for periodic cleanout from the shoulder of the highway.

Stewardship Opportunities: Tree planting and maintenance to insure successful plant establishment.

Location: Highway 99W to Railroad Crossings

Observations: The tight right bend at the inlet to the highway culverts, smaller capacity of the twin box culverts here (as compared to 9th Street), offset channel (abrupt jog left) in the narrow area between the highway and railroad crossings (and complex hydraulics here), and the relatively small span of the railroad bridge itself must all contribute to upstream backwater effects. This is a quintessential situation limiting urban stream rehabilitation, for flood relief or anything else.

The twin box culverts under Highway 99 were both dry when visited on April 28. Creek flow was instead discharging from a partly silted in 36-inch concrete culvert set at a lower grade than the box culverts and outletting about 10 feet north of the left box culvert. The hardened invert under the railroad bridge forms a backwater pool which partly drowns this low-flow culvert, enhancing sediment deposition in it. Someone has placed a picnic table in the left box culvert at its upper end. This obviously could become a major conveyance issue, especially as the table racks up additional flood debris during a high flow event.

Recommendations: A major engineering effort would obviously be required to improve conveyance through this reach. Remove the picnic table from the box culvert under Highway 99W.

Location: Railroad Bridge to Belvue Street Crossing

Observations: The channel downstream of the railroad bridge to the Belvue Street crossing borders the Corvallis Recycling Center, which closely encroaches on the left (north) bank. The right (south) bank is tree lined, providing good shade for suppressing in-channel vegetation growth. While the right bank is encroached upon by a trailer park at the east end of this reach, this bank is quite stable, being covered with ivy. Low-flow channel width varies from 3 to 14 feet or so but even the narrow section is "constrained" by low depositional flood benches: the overall trapezoidal cross section is essentially uninterrupted, providing relatively good conveyance (for this creek). "Average" channel width through the reach is about 10-12 feet and the channel is entrenched about 6-8 feet below grade.

There is substantial fine sediment accumulation immediately upstream of the Belvue Street crossing (which consists of three box culverts). This is in the form of a large marginal bar along the left bank, which is now stabilized by herbaceous growth (mainly reed canarygrass), as well as loose, soft sediments in the low-flow channel itself. Plastic trash has blown into the creek corridor from the east portion of the Recycling Center, which consists of a large parking/operations area.

Recommendations: Since infrastructure encroaches closely on the channel in the upstream portion of this reach, conveyance could be increased by excavating the right bank. However, this would require removal of the native riparian woodland here. In order not to eliminate this woody vegetation, a better choice for enhancing conveyance would be the installation of a steep retaining wall in place of the existing ~1:1 slope on the left bank. Here would be another example of where a "hard" channel rehabilitation approach may be the most environmentally-sensitive strategy since this would preserve the right bank area of streamside woodland.

Along the downstream half of this reach, it is the trailer court along the right bank which closely encroaches on the stream channel. The Recycling Center's asphalt parking/operations borders the channel on the left bank. A strip of this area could potentially be taken to allow bank regrading and enlarge the flood channel cross section, thereby preserving the dense tree cover on the right (south) bank. Alternatively, a retaining wall or steep riprap treatment could be placed on this bank.

It would be helpful to require that the Recycling Center place a fence along their property perimeter. This would help keep trash out of the creek.

Stewardship Opportunities: Tree planting and maintenance to insure successful plant establishment (if any bank work is pursued). Clean-up plastic trash in the creek. (Note: This clean-up effort would be somewhat futile if the Recycling Center is not required to fence off its operations area from the creek since this appears to be the major source of the trash.)

Location: Belvue Street to Jack London Street

Observations: The stream corridor segment between Belvue Street and the newly-constructed Jack London Street crossings consists of a relatively high quality riparian woodland of willow, ash, cottonwood, alder, hawthorn and other native species in the sub-canopy vegetative layers (but including blackberry, especially along the edges). This mix of vegetation produces a nearly impenetrable thicket. There is also substantial downed woody debris within the woodland, although this is mostly smaller material. Channel banks are 4-6 feet high, stable, and comprised of silt/clay. Average channel width is on the order of 8 feet and stream gradient is very flat. Lower average channel width results in some sections of relatively deep water (+1 ft.) in this reach. Racoon tracks were first noticed in this better quality habitat area.

The streambed in this reach consists mainly of silt and very fine sand. There is an especially deep and soft in-channel sediment accumulation immediately downstream of Belvue Street, where a dense willow thicket closely encroaches on the channel. The multiple low branches of these plants tend to trap additional floating debris, thereby impeding the flow. Flow expansion after the culverts, along with the dense willow growth, have evidently produced a stilling effect here, causing extra sediment deposition. The channel-crowding growth of willow in this area demonstrates the potential detrimental effects of using willow plantings along narrow and unmaintained urban stream channels where flow conveyance and flood risk are issues.

Recommendations: Maintain this patch of relatively wide stream corridor to the extent feasible. This area serves as a model of the kind of buffer width which would be desirable to maintain along urban streams generally. For improved conveyance through this reach, excavate the excess sediment which has accumulated immediately downstream of Belvue Street and selectively prune the dense willow growth here.

If substantially improved conveyance is required through this reach, a broad, low flood bench could be created along the left (north) bank. This would necessitate the removal of some woody vegetation but would preserve the generally wooded character of the corridor as well as the shade producing canopy on the south side of the stream. The constructed flood bench could actually diversify habitat conditions in this reach, especially if native herbaceous wetland vegetation is planted on the bench. Native shade-tolerant wetland species, such as certain varieties of sedge (*Carex*), are appropriate for this setting.

Stewardship Opportunities: Selective pruning of the willow growth (supervised) at the upstream end of the reach. Planting wetland species on the constructed flood bench if this option is pursued.

Location: Jack London Street to Railroad R.O.W./Conser Street

Observations: This stretch of stream corridor resembles the upstream reach except that it has now recently been encroached upon by new light industrial facilities. As a result, wooded stream corridor width is now on the order of 50-75 feet wide, with the edges disturbed in many areas (promoting blackberry establishment).

The crossing at Jack London Street is newly installed and this has resulted in a de-vegetated left streambank (now covered with erosion control blanket) and a thick accumulation of fine sediment immediately downstream of the box culverts. Sedimentation in this area is enhanced by the backwater caused by at least two large (for this channel) channel-spanning debris jams not far downstream.

There is an old stream crossing approximately 350 feet upstream of the railroad tracks. The fill forming the crossing appears to have been surfaced with asphalt and is now partly overgrown with grass. The fill is pierced by a 7-foot diameter CM pipe which is filled to approximately ½ of its diameter with large quarried rock and silt (or is actually an arch culvert).

Recommendations: Plant woody streamside plants on left bank adjacent to Jack London Street that has been disturbed by construction (small shrubs low, trees along the upper bank). Remove excess sediment from the channel. Remove the existing debris jams in this reach and selectively prune lower bankside woody vegetation to reduce the tendency for future debris jams. Remove the old culverted stream crossing – this forms an unnecessary pinch point in the channel.

Stewardship Opportunities: Selective pruning of woody lower bank vegetation (supervised) within the corridor. Removal of the debris jams. Replanting of the bank disturbed by construction as well as the bank area disturbed by removal of the old crossing. Maintain plantings until established.

Watershed: OAK CREEK

Date: 1999

Location: Mary's River Confluence to Highway 20

Observations: Oak Creek downstream of Highway 20 (Philomath Boulevard) has a narrow functional floodplain but is confined by high,steep slopes which are covered with native woody vegetation (oak, maple, ash, etc.) as well as extensive thickets of Himalayan blackberry. The gravelly streambed downstream in this reach, down to Oak Creek's confluence with the Mary's River, is structurally un-diverse and consists mostly of riffle habitat. Functional (in-channel) large woody debris or other beneficial instream roughness structures are essentially lacking. Nevertheless, the stream in this reach is not channelized and possesses a sinuous channel planform, alternating point bars, and small scour and corner pools. Also on the plus side, much of the gravel in this reach appears to be only moderately embedded. Although channel shading is generally acceptable, improvements are certainly possible.

There is a substantial obstacle to fish passage approximately35 feet downstream of the twin box culverts under Highway 20. The concrete apron extending 20 feet or so downstream from the culverts is suspended 24-30 inches above the downstream streambed (12-18 inches above the water surface), with a residual (low-flow) pool depth below the drop of less than 12 inches. This represents an impassable barrier to most fish under most flow conditions. Flow over the apron and through the highway culverts is extremely shallow during baseflow conditions, creating an additional barrier to fish passage. The fact that a substantial drop (knickpoint) occurs below the culvert apron suggests an overall pattern of channel degradation on this stream, probably promoted by both channelization and runoff-promoting land use changes in the basin upstream. Further vertical channel adjustment to these changes in the reach immediately upstream is prevented by the Highway 20 culverts, which now replace the Mary's River in providing a local base level of erosion and grade control.

Recommendations: Since Oak Creek reportedly harbors anadromous and resident salmonid fishes, it would be highly desirable to eliminate the fish passage obstacle at Highway 20. This can be accomplished by retrofitting the drop with a naturalistic boulder ramp structure with numerous pocket pools at the outlet from the culverts. Another possible strategy would be the creation of a sequence of stepped boulders weirs with intervening small, self-scouring plunge pools. Such a structure would provide fish passage under most flow conditions. Baffles or other roughness structures could also be retrofit onto the smooth floor of the culverts and over the apron surface to further facilitate the movement of fish between Oak Creek and the Mary's River.

The stream reach downstream of the road crossing, all the way to the confluence with the Mary's River, also offers the opportunity to re-introduce instream structural complexity to this section of Oak Creek. Since there is no downstream culverts at risk of plugging, this could be accomplished by installing highly naturalistic structures, such as engineered log jams, which are currently more commonly deployed along natural streams in undeveloped landscapes. Correctly placed, these could help to create scarce pool habitat and valuable instream hiding and holding cover in this reach of stream. Because of the lack of infrastructure encroachment, the presence of a functional floodplain, and the absence of artificial channel pinch points (culverts) downstream, this area represents a relatively rare instance where "looser" wildland stream rehabilitation prescriptions can be employed in an urban setting without appreciable risk.

Location: Highway 20 to 30th Street

Observations: The culvert inverts under Highway 20 were set high enough to impound water upstream, creating a long dammed pool extending upstream past Morris Avenue. The banks in this reach appear to be quite steep but are almost thoroughly disguised by dense blackberry thickets which overhang the water surface. A few clumps of native shrubbery, such as red osier dogwood, also drape over the pool surface in this reach. Channel width is roughly 20 feet, with the channel entrenched approximately 20 feet below the regional grade.

Concrete rubble becomes an important component of the streambed several hundred feet upstream of Morris Avenue, with lower banks locally revetted with this material. This debris forms a relatively steep, rubble-strewn riffle or "chute" below the 90 degree channel bend at what appears to be an apartment complex just west of 26th Street (the channel alignment changes from north-south to east-west at this location). This area of steeper, pinched low-flow channel appears to be fully fish passable. The upstream end of the demolition debris chute forms a low dam, forcing a relatively deep pool floored with bedrock, silt, and heavily-embedded gravels. This pool extends a considerable distance upstream of the bend in the relatively low-gradient reach here.

The outside (left) bank of the 90 degree bend is bare and eroded, apparently as a result of toe scour and resultant soil falls or slab failures. There has been a recent effort to install erosion control fabric and native vegetation along the top of this high, steep bank, apparently for mainly cosmetic reasons. This effort will ultimately fail as it is undermined by progressive bank erosion. Unfortunately, machine access for effective bank stabilization appears to be hampered here by the adjacent apartment building, which encroaches closely on the channel.

A relative dense stand of native overstory vegetation, consisting predominantly of bigleaf maple, Oregon ash, Garry oak and red alder, commences in the vicinity of the bend and continues in a relatively uninterrupted fashion (except for road crossings) all the way upstream to 35th Avenue (and beyond), the end of the area formally investigated. This vegetation provides good canopy coverage and shade to the creek. Although bare or blackberry covered areas are common along the banks, native snowberry is locally abundant in the shrub layer. There are also a few areas along this reach where red osier dogwood and Pacific ninebark shrubs draper over the channel, providing some measure of cover for instream creatures.

The channel through the reach up to 30th Street, although sinuous, is generally entrenched 15-20 feet below the prevailing grade. Bank materials consist predominantly of silt. As bank slopes are ordinarily steep (1:1 and locally steeper), many of the streamside trees in this long reach have suffered extensive root exposure due to scour, making them weakly rooted and prone to toppling. When they do, they are more likely to promote serious bank erosion in this confined reach than provide much fish habitat, especially where they bridge and remain suspended above the low-flow channel (this was observed in this reach). Because of steep,slopes, sterile substrate and dense shade, much the lower bank area is relatively bare and is this subject to scour erosion. Overall, this appears to occur at chronic, not critical, levels, although relatively small, localized scour pockets and pop-out failures are evident. Some areas of undercut roots occur along scour pools within the low-flow channel, providing locally favorable (but areally very limited) fish habitat.

Portions of the very steep banks in this reach consist of old fill material. This is often eroding and, in some cases, weathered cultural debris such as decades-old cans and glass are being exhumed from the fill face by progressive bank erosion. Homemade bank revetments have also been placed in a few areas within the reach between Western Boulevard and Morris Avenue. A few man-made dams composed of demolition rubble and basalt boulders are also present in this reach, although none of these appears to pose any fish passage issues. The caliber of material used in the dams would probably not resist mobilization and disruption by a very large flow. A number of private water diversion structures were also found in this reach. It is highly likely that these pumps are not permitted with a water right. Some of the observed small boulder dams have been erected to pool water and thus facilitate water abstraction.

The streambed upstream of the pool in the vicinity of the 90 degree bend consists largely of soft bedrock (siltstone or mudstone) with sporadic shallow veneers of gravel. The gravel is patchy in occurrence and is for the most part moderately to severely embedded, although there are few small patches which are relatively free of silt, at least at the surface. Instream habitat consists mainly of riffle and glide with a few small bedrock scour pools (some with submerged undercut ledges). There is essentially no instream large woody debris and the channel is roughly 20 feet wide. The dominant impression of the active channel through this reach from a habitat perspective is that it is essentially featureless, with this low channel complexity therefore allowing few holding opportunities for fish.

Fill was apparently placed decades ago along the left bank of Oak Creek to expand the parking area for the University's Parker Stadium. (It appears that fill was placed up to about this same level on the other side of the creek as well.) Incomplete filling on the stadium side of the creek has resulted in the partial preservation of an intermediate level bench or terrace, which is now well forested with oak, ash and maple, between the stadium parking lot and the channel. This bench appears to be generally about 10 feet above the channel bed. This bench must be very rarely subject to flooding given the relatively large active channel cross section and low channel roughness in this reach. The edge of the stadium fill forms a steep slope roughly 6-8 feet high. Drainage from the stadium parking area has caused local gullying along this slope.

Recommendations: This reach of Oak Creek suffers from significant residential encroachment, along both banks downstream of Western Boulevard and along the right (south) bank in the stadium reach. Close encroachment and steep, high bank slopes which are now colonized by relatively large shade-producing trees offers little opportunity for major enhancement efforts. Significant rehabilitation would require the removal of confining infrastructure and the reprofiling (regrading to a lower, stable angle) of over-steepened channel banks. This would in turn require the removal of streamside trees. Such a level of restoration is probably unrealistic in this area.

A limited, adaptive management approach will presumably be required along this reach (as in so many other urban streams with high infrastructure confinement). Since conveyance is not apparently a problem in lower Oak Creek, the focus of streamwork in this area will undoubtedly be on repairing significant bank failures as they occur and are identified. Because of the simplified nature of this stream reach, instream (lower bank) habitat enhancement aimed at creating additional channel complexity should generally be included in these bank repairs. This could include the creation of additional pool habitat in conjunction with an artificial undercut bank, or the placement of roughness elements such as logs, root wads or boulders to create variable velocity zones, gravel traps and small pools. However, any instream structural habitat enhancement attempted should be carefully planned owing to the high erodibility of lower bank slopes in this reach. Improper design could accentuate local bank erosion and tree falls.

The active bank failure zone at the 90 degree bend in the downstream portion of this reach presently requires stabilization. Since this area includes a significant bend pool (apparently forced by the downstream rubble fill), it would be useful to build low-water structural habitat into this revetment, as discussed above. For example, a log cribwall installed in this highly-confined site could easily incorporate an artificial undercut bank as part of the structure. The revetment could also be designed as a terrace structure, allowing the middle portion of the bank to be planted with shrubby native vegetation such as willow and ninebark, which would eventually drape over the pool. This approach would produce good cover and holding water for fish while solving the bank instability problem.

The left bank adjoining the stadium offers perhaps the only opportunity for a substantial rehabilitation effort in this reach because some portion of the parking area (mainly unpaved) could conceivably be sacrificed. Truly functional rehabilitation in this area could involve substantial reprofiling the waterside slopes, or even lowering, of the remnant flood bench along the left bank. While this would require the removal of large number of established trees, it would also allow the creation of a more natural channel cross section, which in turn would allow energy dissipation and passive flood storage, and improved biological conditions in this reach. Although many trees would be removed, these are on the northeast bank of the creek and thus are not so critical to channel shading as those on the right bank. Any efforts to pull back banks on the stadium side would also reduce erosive pressure on the steep, unstable opposite bank of the stream, where infrastructure encroachment prevents much meaningful work. This would help to preserve the existing large trees here, which are valuable for channel shade. With this level of alterations, instream habitat enhancements could also be conveniently installed as part of the rehabilitation project.

Location: 30th Street to 35th Street

Observations: Note: Flow levels at the time this reach was investigated (12/99) were too high to walk the channel. Blackberry thickets also located prevented access to significant portions of the channel margin.

Rock fill under the 30th Street bridge has created an armored riffle which encourages lateral bank erosion under high flow conditions. This material also appears to force a long backwater pool upstream in this relatively low-gradient reach. The rock accumulation does not appear to create an obstacle to fish passage.

A small boulder dam has been reported approximately 100 feet upstream of 30th Street in a previous discussion of this reach (Benner 1984). This dam was not observed in December of 1999, although it may have been drowned out by the higher stream flow of this time of the year. If this is the case, the dam would presumably be small enough that it is unlikely to preclude fish passage even during lower flows. (The dam may also have been removed by the high flows of the last several years.)

There is a large diameter pipe crossing the channel 30 feet or so upstream of the 30th Street bridge. This was only about one foot or so above the water surface under apparently ordinary winter flow conditions (12/22/99). This pipe is this at some considerable risk of failure due to debris jams as large toppled trees are in the channel not far upstream and this material (as well as freshly toppled trees; see below) could presumably drift downstream during a very high stream flow period.

After the suspended culvert apron below Highway 20, the next significant fish passage barrier upstream on Oak Creek is an old engineered metal dam, presumably erected for water diversion, located about 250 feet downstream of the 35th Street bridge. This has two spillways which appear passable for larger fish under higher flow conditions but would presumably constitute a barrier to upstream migration under lower flow situations (residual pool depth could not be measured). The pool upstream of the dam appears to have been largely filled with sediment (with a predominantly gravel texture, at least as a surface armor) and a large gravel and sand bar has accumulated along the left bank downstream of 35th Street, which is apparently within the backwater of the dam. Thus, a very large wedge of sediment wedge of sediment has accumulated upstream of this dam.

General channel bed and bank conditions are much the same in this reach as they are below 30th Street. Entrenchment below the regional grade near the 30th Street bridge is roughly 20 feet but this gradually declines upstream until it is less than 10 feet or so near 35th Street. A portion of the remnant floodplain surface discussed earlier is also preserved along the left bank just upstream of 30th Street.

Canopy coverage is generally good, with a similar mix of overstory species as downstream, although Himalayan blackberry thickets are far more abundant in this reach. On the other hand, infrastructure encroachment is less here than along Oak Creek downstream of 30th Street, although what are apparently University facilities do closely approach the channel along the right bank in the lower end of the reach. A number of stormwater pipes associated with these facilities jut from the bank without the benefit of energy-dissipating aprons, causing local bank erosion.

Streambanks are over-steepened and as steep or steeper than in the downstream reach (banks are vertical in a few places) and consist predominantly fine-grained material and non-engineered fills. Demolition debris has been placed as a haphazard revetment in many places and this is itself locally failing and exacerbating scour erosion.

Because of over-steepened banks, many of the trees rooted on these slopes are prone to scour and eventual toppling. Several large fallen trees have accumulated in the channel several hundred feet upstream of 30th Street. Although they are adding structural diversity to the channel, they are also encouraging fluvial erosion and slumping because of the entrenched channel condition. There is large slump scar on the left bank in this vicinity which is 30 feet wide and more than 15 feet high.

The largest observed bank failure observed in this reach was located on the left bank around 700 feet or so downstream of the steel dam. The failed bank is about 75 feet long and 10 feet high. A large tree, still rooted on the lower bank but now partially detached from it by scour, forms the downstream end of the failure zone. This is likely to promote further bank erosion in this immediate area.

Recommendations: Fish passage should be insured at the steel dam. The dam could be removed, although upstream streambed grade has become adjusted to it's presence and removal would presumably result in the evacuation of a huge quantity of sediment (probably much of this consisting of sand and finer fractions) if significant countermeasures were not taken to prevent this. The excavation and disposal of so much sediment could be costly, although there may be opportunities to "lose" this on site. Significant bank stabilization efforts would also probably be required if the dam were removed outright. The dam could also potentially be retrofit with an engineered fish ladder. However, in the interest of longer term re-naturalization of the creek corridor, it might be preferable to remove the dam and replace it with a fully fish passable and naturalistic grade control structure, presumably constructed of large boulders.

Active bank failures are prominent in ths reach. These should be treated immediately since they represent significant fine sediment sources for the stream. As before, direct structural habitat enhancement should be incorporated within bank treatments wherever feasible. The largest bank failure identified in this reach is readily accessible by machinery. It is likely that this area could be stabilized by the installation of boulder/root wad bank toe (to resist scour and provide habitat), with simple bank reprofiling, erosion control matting installation, and replanting above this.

There are large areas of open space along this reach of Oak Creek. The upstream segment of the stream is mainly bordered by pasture or hay meadow. Since depth of entrenchment is also reduced in this upstream area, bank slope reprofiling and functional floodplain re-creation become viable options (at least from a technical perspective) in this reach of stream. Stream channel / floodplain recoupling and associated instream habitat enhancement and riparian restoration would seem to be a particularly appropriate activity on University property.

Location: Oak Creek Upstream of 35th Street

Observations: Only a small portion of Oak Creek upstream of 35th Street (upstream of the railroad R.O.W., along Washington Way) was briefly investigated in the spring of 1998 (with P. Benner). The channel is incised about 15 feet here and possessed the same general type of native deciduous tree canopy observed downstream (ash, oak, alder, bigleaf maple, cottonwood). Understory vegetation included natives species (e.g. rose, snowberry, red osier dogwood) in addition to dense blackberry thickets and ivy-covered areas. Much of this woody riparian vegetation has grown up through old fills and revetments of demolition debris. At least in this small area, instream habitat complexity was generally far greater than found downstream of 35th Street. Complexity is provide by apparently stable undercut tree roots and toppled large woody debris, including a few *bona fide* woody debris jams (in 1998). Unfortunately, extensive dumping this area has significantly impacted the visual quality of the channel.

Apart from those already mentioned, the only other known fish passage barrier between the Mary's River and the higher-quality habitat in the rural areas upstream of Harrison Boulevard is the water diversion dam located just downstream of Harrison. This appears to create an impassable fish barrier.

Where locally observed (such as at road crossings, Bald Hill State Park), much of Oak Creek in the rural area upstream of the main Oregon State University Campus appears to possess good water quality and surprisingly clean, potentially spawnable gravels. Riparian canopy coverage is also generally good in the areas observed and depth of entrenchment is usually much less than on the lower reaches of the stream within the urban area.

APPENDIX C
TECHNICAL MEMORANDUM NO. 1

Hydraulic and Hydraulic Modeling Methodology and Results

TECHNICAL MEMORANDUM No. 1

TO: Bruce Moser, City of Corvallis

FROM: Jim Hansen, Brown and Caldwell

DATE: December 2000

PREPARED BY: Dale Lough, Brown and Caldwell

REVIEWED BY: Steve Merrill, Brown and Caldwell

SUBJECT: Hydrologic/Hydraulic Modeling Methodology and Results

PROJECT: Corvallis Stormwater Master Plan

CONTENTS

TABLES

1.0 INTRODUCTION

Dixon Creek, Squaw Creek, Sequoia Creek, Jackson Creek, Frazier Creek, Oak Creek, Village Green Creek, the Garfield area, and portions of South Corvallis and the Marys River drainage were modeled as part of the City of Corvallis (City) Stormwater Master Plan (SWMP) project. This technical memorandum describes the model selection, modeling methodology, calibration, and the model results. The physical parameters and assumptions used in the modeling are described in the modeling methodology section of this technical memorandum.

2.0 MODEL SELECTION

XP-SWMM was selected as the model for this project. This model is currently used by the City and allows for a detailed examination of flooding, backwater, and velocity issues within the pipes and open channels that comprise the stormwater conveyance system. SWMM, the core component of XP-SWMM, has been applied extensively to similar projects throughout this country and others. The U.S. Environmental Protection Agency maintains SWMM, with support from Oregon State University. XP-SWMM version 5.2 is the release used throughout the project.

3.0 MODELING METHODOLOGY

The following subsections describe the methods used to calculate the model parameters. The subsections include subwatershed delineation, design storms, runoff parameters, conveyance system, and modeling scenarios.

3.1 Watershed/Subwatershed Delineation

Based on topography, stormwater conveyance system and likelihood of future development, each tributary basin was divided into subbasins as shown in Figures 1 and 2. The subbasins range in size from 0.7 to 2,352 acres, and form the hydrologic units of the model. Oak Creek contains the largest number of subbasins due to its location outside of the urban growth boundary. See Table TM1-1 for detailed watershed information.

Table TM1-1. Watershed and Subwatershed Areas

Watershed name	Watershed, acres	Number of subwatersheds	Subwatershed minimum, acres	Subwatershed mean, acres	Subwatershed maximum, acres
Dixon Creek	2,712	96	2	28	250
Frazier Creek	2,254	12	39	188	424
Garfield Creek	346	12	5	29	151
Jackson Creek	1,798	9	109	200	316
Marys River	78	3	12	26	44
Oak Creek	8,308	30	21	277	2,352
Sequoia Creek	1,357	25	10	54	233
South Corvallis (Goodnight)	298	23	0.7	13	48
South Corvallis (Millrace)	349	6	19	44	84
Squaw Creek	2,363	31	12	76	468
Village Green Creek	380	9	7	42	77
Total	**20,243**	**256**			

3.2 Design Storm

The design storm utilized for this project was the rainfall pattern from December 24 to 29, 1998 (see Table A-1 in the Appendix). During this 5-day period, 5.15 inches of rain fell, 3.64 inches of which fell in the 24-hour period beginning at 1:00 p.m. on December 27. This 24-hour intensity is approximately equal to the 10-year event for Corvallis predicted by the Oregon Climate Service. (The 10-year event has a 10 percent chance of occurring in any given year or, in other words, is expected to occur on average once in every 10 years). The days before and after the critical 24 hours were included in the model runs to allow the model time to come to equilibrium. The entire December 24 to 29, 1998 storm distribution is graphed in TM1-3.

The rainfall distribution for the other storms modeled, the 2-, 5-, 25-, and 100-year storms, was obtained by multiplying the 10-year storm volume by the factors listed in Table TM1-2.

Table TM1-2. Design Storm Rainfall Multiplier

Return Frequency (years)	2	5	10	25	100
Multiplier	0.7	0.8	1.0	1.1	1.3

The rainfall date used for modeling comes from a City-maintained rainfall gauge at the wastewater treatment plant. The treatment plant is located in the valley portion of the watershed just to the west of the Willamette River. It has been observed that rainfall amounts measured in the headwaters of several basins (Jackson, Frazier, and Oak Creeks) are typically higher than those measured at the Corvallis Wastewater Treatment Plant. In order to account for this difference, the modeled rainfall amounts in several upper-basin subbasins of Jackson, Frazier, and Oak Creek were adjusted based on average rainfall data for Benton County mapped by the Oregon Climate Service. Jackson and Frazier Creeks' modeled rainfall amounts were adjusted upward by 17 percent. Oak Creek's modeled rainfall amount was adjusted upward by 33 percent.

Adjusted real storm data was used in lieu of the traditional synthetic design storms, such as the Soil Conservation Service (SCS) Type IA distribution, to more closely approximate runoff peaks and volumes found in Corvallis. The SWMM model reflects that peak flows in storm water systems are highly dependent on antecedent conditions. The peak flow rate generated from a given storm may have a greater recurrence interval than the rainfall, due to prior rainfall saturation of the soil and increasing runoff. Huber *(Stormwater Management Model User's Manual, Version III*, Huber, et. al., 1981) makes note of this effect by pointing out that design storms constructed from SCS distributions and 24-hour rainfall volumes create higher peaks and lower total volumes than are observed in long (40+ year) simulations with actual rainfall. The SCS distributions do not account for antecedent rainfall and allow too much of the rainfall to infiltrate at the beginning of the storm.

In the Northwest, rainfall with a Type IA distribution occurs at a much lower frequency than 24-hour rainfall volumes. Thus, using an SCS Type IA distribution with a 10-year rainfall volume may result in an event with a probability of occurrence lower than once in 10 years.

3.3 Runoff Parameters

This section describes the parameters utilized in the RUNOFF block of the SWMM program. The RUNOFF block calculates the amount of runoff originating from each subwatershed in the models. Values for the runoff parameters, including impervious percentage, width, and slope, are listed in Table A-2 in the Appendix.

3.3.1 Impervious Area

The mapped impervious percentages assigned to each land use were based on measurements of impervious areas shown on Geographic Information System (GIS) maps of representative land uses in Corvallis. The percentages were then applied to existing land use reported in the Corvallis tax lot coverage, and future land use based on comprehensive plan zoning. Present and future information is presented in Tables TM1-3 and TM1-4, respectively.

Table TM1-3. Imperviousness by Land Use, Present

Zoning	COMM	COMH	IND	OSA	OSF	PUB	RESL	RESM	RESH	VAC
Description	Commercial, medium	Govern-ment, high	Industrial	Open space/ agricultural	Open space/ forested	Public/ institu-tional	Single family residential light	Single family residential medium	Single family residential heavy	Vacant
Mapped impervious cover %	88	88	60	15	5	70	40	50	63	10

Table TM1-4. Imperviousness by Land Use, Future

Zoning	COMM	COMH	INDL	INDM	INDH	OSA	OSC	OSF	PUB	RESL	RESM	RESH	RT
Description	Commer-cial, medium	Commer-cial, high	Industrial, low	Industrial, medium	Industrial, high	Open space/ agricultural	Open space/ conserva tion	Open space/ forested	Public/ institu-tional	Single family residential light	Single family residential medium	Single family residential heavy	Research technology
Mapped impervious cover %	87	90	51	61	65	15	5	5	70	40	50	63	76

The effective impervious percentages, those areas directly connected to the conveyance system, were calculated for each subwatershed based upon the degree to which the conveyance system is piped in that location. An area with rooftops that drain to lawns or ditches instead of draining to curbs and gutters have less effective impervious areas than those directly connected to pipes. Formulas developed in previous studies for the Portland area were used for this conversion (Sutherland, 1987). The effective impervious area was then plugged into the SWMM model as the impervious percent for each subwatershed.

3.3.2 Pervious Area

Fine-grained soils found in Corvallis contribute to the high rate of runoff in the watersheds that were modeled. The main factor that determines how much water can infiltrate into the ground in previous areas is the soil type. The SCS recognizes four hydrologic soil types, A, B, C, and D. Type D soils are made up of clays that have the lowest infiltration rates of the four soil types, resulting in the most runoff. About 60 percent of the soils are classified as SCS (USDA, 1986) Hydrologic Type D soils. Type C soils are fine silts, with slightly higher infiltration rates. They make up 28 percent of the soils in the area. About 12 percent of the soils are classified as Type B silts or fine sands. A negligible amount of the coarser, more quickly draining Type A sands are also present.

Infiltration from pervious areas was computed by means of the Green-Ampt equations (Huber, 1992). This method makes use of physically based parameters that can be predicted for various soil types. Base parameters were taken from literature and then modified to reflect calibration data where possible. To better reflect the saturated soil conditions during the prolonged winter storms in the Corvallis area, the model was constructed with a very low value for the hydraulic conductivity.

3.3.3 Subbasin Width

The width parameter in SWMM is related to the time of concentration. This parameter is typically estimated by dividing the total subbasin area by its maximum length of overland flow. The maximum length and area are determined with the GIS for each subbasin.

3.3.4 Subbasin Slope

The subbasin slope is the average slope along the various pathways of overland flow. This value is used for the portions of the subbasin in which runoff is not confined within a channel or pipe.

3.4 Conveyance System

The Corvallis conveyance system consists mainly of urban streams with culverts and bridges at road crossings and a pipe system that transports runoff to the streams from upland areas.

Pipe/culvert size, slope, and elevations used in the model were based upon:

- Information provided by City staff
- Site visits by the modelers

Not all pipes in the system were modeled, due to scope limitations that confined efforts to the main stream channels. The modeling did include chronic problem areas within the watershed outside of the main channels that were reported by residents and City staff.

When slopes were not available, they were estimated based upon computerized topographic maps. Details of the modeled conveyance system are provided in the Appendix as Tables A-3 and A-4.

The width, depth, and other channel cross-section information was based on selected stream segments surveyed by City crews. Channel conditions, such as bank roughness, were based on site visits by the consultant team.

A hydraulic model, such as SWMM, allows excess flows to back up behind a constriction in the system. These flows can then be lost to the system, stored until they can pass the constriction, or passed downstream through an overflow route. In the Corvallis model, excess flows were handled in different ways depending on the situation. In piped systems, flows were allowed to back up in upstream manholes and stored until they could be passed downstream. At culverts and bridges, they were allowed to back up behind the structure up to the elevation of the roadway, at which point they were routed downstream. In open channels, flows which exceeded the base channel capacity were contained within the overbank, where they were slowed down.

3.5 Modeling Scenarios

Two scenarios were modeled for the master plan. The first examined the existing conditions within each basin. The second projected flows into the future by utilizing the City of Corvallis Draft Comprehensive Plan. Existing flows were modeled in order to compare results with field observations. Future flows were modeled to identify problem areas.

4.0 CALIBRATION

No gauged flow or flood stage data was available for model calibration during this study. Instead, model results were mainly compared to reports on water elevations during storm events provided by City staff and the public. The best elevation data available for this study were water surface elevations reported during the December 24 to 29, 1998 storm. These model results were compared to the new XP-SWMM models. Table TM1-5 presents the results of the calibration effort for Dixon and Squaw Creeks, the two creeks for which City staff recorded water levels during the storm.

Table TM1-5. Calibration Results

Location	Reported Elevation, feet	Modeled Elevation, feet
Dixon Creek		
9th Street Bridge	217.8	218.6
Grant Avenue Bridge	224.2	225.4
Garfield Avenue Bridge	228.3	228.3
Circle Boulevard Bridge	240.0	240.2
Squaw Creek		
Knollbrook Place Bridge	225.7	228.6
Country Club Place Culverts	237.5	237.6

Other sources were also used for comparison purposes. The City's map of flooded roads and high water during the February 1996 storm were used, as were reports of flooding and erosion problems from the public. In addition, flows modeled during the Corvallis Drainage Master Plan (CH_2M Hill, 1981), were also analyzed, although this earlier effort also lacked gauged data for comparison.

5.0 MODEL RESULTS

Peak flow results were used to determine the adequacy of pipe, culverts, and bridges. If the peak flow predicted by the model exceeded the pipe full or bank full capacity of a conduit, the conduit was considered undersized. Backwater effects from constrictions or hydraulic transitions may also cause capacity problems. Surcharged or flooded nodes results were used to determine problem areas resulting from backwater effects. Refer to Table A-5 in the Appendix for flow results.

Peak velocity results were used to evaluate the potential for erosion in the modeled channels. A description of the range of velocities of concern is presented in Chapter 4 of the SWMP. Refer to Table A-6 in the Appendix for modeled velocities.

Much of the flooding reported by citizens was the result of backwater effects from the Marys and Willamette Rivers. The modeling did not examine flooding due to this, because it is beyond the City's ability to control.

6.0 REFERENCES

Huber, W. C., J. P. Heaney, L. J. Nix, R. E. Dickinson, and D. J. Pulmann, "Stormwater Management Model User's Manual, Version III", EPA 600/2-84-109a (NTIS PB84-198432), November 1981.

Huber, W. C., and R. E. Dickinson, "Storm Water Management Model, Version 4: User's Manual", EPA/600/3-88/001a (NTIS PB88-236641/AS), October 1992.

Sutherland, R. C., 1987. Methodology for estimating effective impervious area for natural, partially urbanized, and urban watersheds based on published U.S.G.S. data for watersheds throughout the metropolitan areas of Portland and Salem, Oregon.

USDA, 1986. Urban Hydrology for Small Watersheds. Soil Conservation Service Technical Release 55.

TABLE A-1

DECEMBER 24 – 29, 1998
STORM DISTRIBUTION

Table A-1. December 24-29, 1998 Storm Distribution

Month	Day	Time	Inches		Month	Day	Time	Inches		Month	Day	Time	Inches
Dec	24	11:58	0		Dec	24	16:19	0		Dec	24	20:40	0
Dec	24	12:03	0		Dec	24	16:24	0		Dec	24	20:45	0
Dec	24	12:09	0		Dec	24	16:29	0		Dec	24	20:50	0.01
Dec	24	12:14	0		Dec	24	16:35	0		Dec	24	20:55	0.01
Dec	24	12:19	0		Dec	24	16:40	0		Dec	24	21:01	0
Dec	24	12:24	0		Dec	24	16:45	0		Dec	24	21:06	0.01
Dec	24	12:29	0		Dec	24	16:50	0.01		Dec	24	21:11	0.01
Dec	24	12:34	0		Dec	24	16:55	0		Dec	24	21:16	0
Dec	24	12:39	0		Dec	24	17:00	0		Dec	24	21:21	0
Dec	24	12:44	0		Dec	24	17:05	0		Dec	24	21:26	0.01
Dec	24	12:49	0		Dec	24	17:10	0		Dec	24	21:31	0
Dec	24	12:55	0		Dec	24	17:15	0.01		Dec	24	21:36	0
Dec	24	13:00	0		Dec	24	17:21	0.01		Dec	24	21:41	0
Dec	24	13:05	0		Dec	24	17:26	0		Dec	24	21:47	0
Dec	24	13:10	0		Dec	24	17:31	0		Dec	24	21:52	0
Dec	24	13:15	0		Dec	24	17:36	0		Dec	24	21:57	0
Dec	24	13:20	0		Dec	24	17:41	0		Dec	24	22:02	0.01
Dec	24	13:25	0		Dec	24	17:46	0.01		Dec	24	22:07	0
Dec	24	13:30	0		Dec	24	17:51	0		Dec	24	22:12	0
Dec	24	13:35	0		Dec	24	17:56	0		Dec	24	22:17	0
Dec	24	13:41	0		Dec	24	18:01	0		Dec	24	22:22	0.01
Dec	24	13:46	0		Dec	24	18:07	0.01		Dec	24	22:27	0
Dec	24	13:51	0		Dec	24	18:12	0		Dec	24	22:33	0
Dec	24	13:56	0		Dec	24	18:17	0		Dec	24	22:38	0.01
Dec	24	14:01	0		Dec	24	18:22	0		Dec	24	22:43	0
Dec	24	14:06	0		Dec	24	18:27	0		Dec	24	22:48	0
Dec	24	14:11	0		Dec	24	18:32	0		Dec	24	22:53	0
Dec	24	14:16	0		Dec	24	18:37	0.01		Dec	24	22:58	0
Dec	24	14:22	0		Dec	24	18:42	0		Dec	24	23:03	0
Dec	24	14:27	0		Dec	24	18:48	0		Dec	24	23:08	0
Dec	24	14:32	0		Dec	24	18:53	0		Dec	24	23:14	0
Dec	24	14:37	0		Dec	24	18:58	0		Dec	24	23:19	0
Dec	24	14:42	0		Dec	24	19:03	0		Dec	24	23:24	0
Dec	24	14:47	0		Dec	24	19:08	0		Dec	24	23:29	0
Dec	24	14:52	0		Dec	24	19:13	0		Dec	24	23:34	0
Dec	24	14:57	0		Dec	24	19:18	0		Dec	24	23:39	0
Dec	24	15:02	0		Dec	24	19:23	0		Dec	24	23:44	0
Dec	24	15:08	0		Dec	24	19:28	0		Dec	24	23:49	0
Dec	24	15:13	0		Dec	24	19:34	0		Dec	24	23:54	0
Dec	24	15:18	0		Dec	24	19:39	0		Dec	25	0:00	0.01
Dec	24	15:23	0		Dec	24	19:44	0		Dec	25	0:05	0
Dec	24	15:28	0		Dec	24	19:49	0		Dec	25	0:10	0
Dec	24	15:33	0		Dec	24	19:54	0		Dec	25	0:15	0
Dec	24	15:38	0		Dec	24	19:59	0		Dec	25	0:20	0
Dec	24	15:43	0		Dec	24	20:04	0		Dec	25	0:25	0
Dec	24	15:48	0		Dec	24	20:09	0		Dec	25	0:30	0
Dec	24	15:54	0		Dec	24	20:14	0		Dec	25	0:35	0
Dec	24	15:59	0		Dec	24	20:20	0		Dec	25	0:40	0
Dec	24	16:04	0		Dec	24	20:25	0.01		Dec	25	0:46	0
Dec	24	16:09	0		Dec	24	20:30	0		Dec	25	0:51	0
Dec	24	16:14	0		Dec	24	20:35	0		Dec	25	0:56	0

Table A-1. December 24-29, 1998 Storm Distribution

Month	Day	Time	Inches		Month	Day	Time	Inches		Month	Day	Time	Inches
Dec	25	1:01	0		Dec	25	5:22	0		Dec	25	9:43	0.01
Dec	25	1:06	0		Dec	25	5:27	0		Dec	25	9:48	0
Dec	25	1:11	0		Dec	25	5:32	0		Dec	25	9:53	0
Dec	25	1:16	0		Dec	25	5:37	0		Dec	25	9:58	0.01
Dec	25	1:21	0		Dec	25	5:42	0		Dec	25	10:03	0
Dec	25	1:27	0		Dec	25	5:47	0		Dec	25	10:08	0
Dec	25	1:32	0		Dec	25	5:53	0		Dec	25	10:13	0.01
Dec	25	1:37	0		Dec	25	5:58	0.01		Dec	25	10:19	0.01
Dec	25	1:42	0		Dec	25	6:03	0		Dec	25	10:24	0.01
Dec	25	1:47	0		Dec	25	6:08	0		Dec	25	10:29	0.01
Dec	25	1:52	0		Dec	25	6:13	0		Dec	25	10:34	0
Dec	25	1:57	0		Dec	25	6:18	0		Dec	25	10:39	0.01
Dec	25	2:02	0		Dec	25	6:23	0.01		Dec	25	10:44	0
Dec	25	2:07	0		Dec	25	6:28	0		Dec	25	10:49	0.01
Dec	25	2:13	0		Dec	25	6:33	0		Dec	25	10:54	0
Dec	25	2:18	0		Dec	25	6:39	0.01		Dec	25	10:59	0
Dec	25	2:23	0		Dec	25	6:44	0		Dec	25	11:05	0
Dec	25	2:28	0		Dec	25	6:49	0		Dec	25	11:10	0
Dec	25	2:33	0		Dec	25	6:54	0		Dec	25	11:15	0
Dec	25	2:38	0		Dec	25	6:59	0.01		Dec	25	11:20	0
Dec	25	2:43	0		Dec	25	7:04	0		Dec	25	11:25	0
Dec	25	2:48	0		Dec	25	7:09	0		Dec	25	11:30	0.01
Dec	25	2:53	0		Dec	25	7:14	0		Dec	25	11:35	0
Dec	25	2:59	0		Dec	25	7:19	0		Dec	25	11:40	0
Dec	25	3:04	0		Dec	25	7:25	0		Dec	25	11:45	0
Dec	25	3:09	0		Dec	25	7:30	0		Dec	25	11:51	0
Dec	25	3:14	0		Dec	25	7:35	0		Dec	25	11:56	0
Dec	25	3:19	0		Dec	25	7:40	0		Dec	25	12:01	0.01
Dec	25	3:24	0		Dec	25	7:45	0.01		Dec	25	12:06	0
Dec	25	3:29	0		Dec	25	7:50	0		Dec	25	12:11	0
Dec	25	3:34	0		Dec	25	7:55	0		Dec	25	12:16	0
Dec	25	3:40	0		Dec	25	8:00	0		Dec	25	12:21	0
Dec	25	3:45	0		Dec	25	8:06	0		Dec	25	12:26	0
Dec	25	3:50	0		Dec	25	8:11	0		Dec	25	12:32	0
Dec	25	3:55	0		Dec	25	8:16	0.01		Dec	25	12:37	0
Dec	25	4:00	0		Dec	25	8:21	0		Dec	25	12:42	0
Dec	25	4:05	0		Dec	25	8:26	0		Dec	25	12:47	0.01
Dec	25	4:10	0		Dec	25	8:31	0		Dec	25	12:52	0
Dec	25	4:15	0		Dec	25	8:36	0.01		Dec	25	12:57	0
Dec	25	4:20	0		Dec	25	8:41	0		Dec	25	13:02	0
Dec	25	4:26	0		Dec	25	8:46	0		Dec	25	13:07	0
Dec	25	4:31	0		Dec	25	8:52	0		Dec	25	13:12	0
Dec	25	4:36	0		Dec	25	8:57	0.01		Dec	25	13:18	0
Dec	25	4:41	0		Dec	25	9:02	0		Dec	25	13:23	0
Dec	25	4:46	0		Dec	25	9:07	0		Dec	25	13:28	0.01
Dec	25	4:51	0		Dec	25	9:12	0		Dec	25	13:33	0
Dec	25	4:56	0		Dec	25	9:17	0		Dec	25	13:38	0
Dec	25	5:01	0		Dec	25	9:22	0.01		Dec	25	13:43	0
Dec	25	5:06	0		Dec	25	9:27	0		Dec	25	13:48	0
Dec	25	5:12	0		Dec	25	9:32	0		Dec	25	13:53	0
Dec	25	5:17	0		Dec	25	9:38	0		Dec	25	13:59	0

Table A-1. December 24-29, 1998 Storm Distribution

Month	Day	Time	Inches	Month	Day	Time	Inches	Month	Day	Time	Inches
Dec	25	14:04	0	Dec	25	18:25	0	Dec	25	22:45	0
Dec	25	14:09	0	Dec	25	18:30	0	Dec	25	22:51	0
Dec	25	14:14	0	Dec	25	18:35	0	Dec	25	22:56	0
Dec	25	14:19	0	Dec	25	18:40	0	Dec	25	23:01	0
Dec	25	14:24	0	Dec	25	18:45	0	Dec	25	23:06	0
Dec	25	14:29	0.01	Dec	25	18:50	0	Dec	25	23:11	0
Dec	25	14:34	0	Dec	25	18:55	0	Dec	25	23:16	0
Dec	25	14:39	0.01	Dec	25	19:00	0	Dec	25	23:21	0
Dec	25	14:45	0	Dec	25	19:05	0	Dec	25	23:26	0
Dec	25	14:50	0.01	Dec	25	19:11	0	Dec	25	23:31	0
Dec	25	14:55	0	Dec	25	19:16	0	Dec	25	23:37	0
Dec	25	15:00	0.01	Dec	25	19:21	0	Dec	25	23:42	0
Dec	25	15:05	0	Dec	25	19:26	0	Dec	25	23:47	0
Dec	25	15:10	0	Dec	25	19:31	0	Dec	25	23:52	0
Dec	25	15:15	0	Dec	25	19:36	0	Dec	25	23:57	0
Dec	25	15:20	0.01	Dec	25	19:41	0	Dec	26	0:02	0
Dec	25	15:25	0	Dec	25	19:46	0	Dec	26	0:07	0
Dec	25	15:31	0	Dec	25	19:51	0	Dec	26	0:12	0
Dec	25	15:36	0	Dec	25	19:57	0	Dec	26	0:17	0
Dec	25	15:41	0	Dec	25	20:02	0	Dec	26	0:23	0
Dec	25	15:46	0	Dec	25	20:07	0	Dec	26	0:28	0
Dec	25	15:51	0	Dec	25	20:12	0	Dec	26	0:33	0
Dec	25	15:56	0	Dec	25	20:17	0	Dec	26	0:38	0
Dec	25	16:01	0	Dec	25	20:22	0	Dec	26	0:43	0
Dec	25	16:06	0	Dec	25	20:27	0	Dec	26	0:48	0
Dec	25	16:12	0	Dec	25	20:32	0	Dec	26	0:53	0
Dec	25	16:17	0	Dec	25	20:38	0	Dec	26	0:58	0
Dec	25	16:22	0	Dec	25	20:43	0	Dec	26	1:04	0
Dec	25	16:27	0	Dec	25	20:48	0	Dec	26	1:09	0
Dec	25	16:32	0	Dec	25	20:53	0	Dec	26	1:14	0
Dec	25	16:37	0	Dec	25	20:58	0	Dec	26	1:19	0
Dec	25	16:42	0	Dec	25	21:03	0	Dec	26	1:24	0
Dec	25	16:47	0	Dec	25	21:08	0	Dec	26	1:29	0
Dec	25	16:52	0	Dec	25	21:13	0	Dec	26	1:34	0
Dec	25	16:58	0.01	Dec	25	21:18	0	Dec	26	1:39	0
Dec	25	17:03	0	Dec	25	21:24	0	Dec	26	1:44	0
Dec	25	17:08	0	Dec	25	21:29	0	Dec	26	1:50	0
Dec	25	17:13	0	Dec	25	21:34	0	Dec	26	1:55	0
Dec	25	17:18	0	Dec	25	21:39	0	Dec	26	2:00	0
Dec	25	17:23	0	Dec	25	21:44	0	Dec	26	2:05	0
Dec	25	17:28	0	Dec	25	21:49	0	Dec	26	2:10	0
Dec	25	17:33	0	Dec	25	21:54	0	Dec	26	2:15	0
Dec	25	17:38	0	Dec	25	21:59	0	Dec	26	2:20	0
Dec	25	17:44	0	Dec	25	22:04	0	Dec	26	2:25	0
Dec	25	17:49	0	Dec	25	22:10	0	Dec	26	2:30	0
Dec	25	17:54	0	Dec	25	22:15	0	Dec	26	2:36	0
Dec	25	17:59	0	Dec	25	22:20	0	Dec	26	2:41	0.01
Dec	25	18:04	0	Dec	25	22:25	0	Dec	26	2:46	0
Dec	25	18:09	0	Dec	25	22:30	0	Dec	26	2:51	0
Dec	25	18:14	0	Dec	25	22:35	0	Dec	26	2:56	0
Dec	25	18:19	0	Dec	25	22:40	0	Dec	26	3:01	0

Table A-1. December 24-29, 1998 Storm Distribution

Month	Day	Time	Inches	Month	Day	Time	Inches	Month	Day	Time	Inches
Dec	26	3:06	0	Dec	26	7:27	0	Dec	26	11:48	0
Dec	26	3:11	0	Dec	26	7:32	0	Dec	26	11:53	0
Dec	26	3:17	0	Dec	26	7:37	0	Dec	26	11:58	0
Dec	26	3:22	0	Dec	26	7:43	0	Dec	26	12:03	0
Dec	26	3:27	0	Dec	26	7:48	0.01	Dec	26	12:09	0
Dec	26	3:32	0	Dec	26	7:53	0	Dec	26	12:14	0
Dec	26	3:37	0	Dec	26	7:58	0	Dec	26	12:19	0
Dec	26	3:42	0	Dec	26	8:03	0	Dec	26	12:24	0
Dec	26	3:47	0	Dec	26	8:08	0	Dec	26	12:29	0
Dec	26	3:52	0	Dec	26	8:13	0	Dec	26	12:34	0
Dec	26	3:57	0	Dec	26	8:18	0	Dec	26	12:39	0
Dec	26	4:03	0	Dec	26	8:23	0	Dec	26	12:44	0
Dec	26	4:08	0	Dec	26	8:29	0	Dec	26	12:49	0
Dec	26	4:13	0	Dec	26	8:34	0	Dec	26	12:55	0
Dec	26	4:18	0	Dec	26	8:39	0	Dec	26	13:00	0
Dec	26	4:23	0	Dec	26	8:44	0	Dec	26	13:05	0
Dec	26	4:28	0	Dec	26	8:49	0	Dec	26	13:10	0
Dec	26	4:33	0	Dec	26	8:54	0	Dec	26	13:15	0
Dec	26	4:38	0	Dec	26	8:59	0	Dec	26	13:20	0
Dec	26	4:43	0	Dec	26	9:04	0	Dec	26	13:25	0
Dec	26	4:49	0	Dec	26	9:09	0	Dec	26	13:30	0
Dec	26	4:54	0	Dec	26	9:15	0	Dec	26	13:35	0
Dec	26	4:59	0	Dec	26	9:20	0	Dec	26	13:41	0
Dec	26	5:04	0	Dec	26	9:25	0	Dec	26	13:46	0
Dec	26	5:09	0	Dec	26	9:30	0	Dec	26	13:51	0
Dec	26	5:14	0	Dec	26	9:35	0	Dec	26	13:56	0
Dec	26	5:19	0	Dec	26	9:40	0	Dec	26	14:01	0
Dec	26	5:24	0	Dec	26	9:45	0	Dec	26	14:06	0
Dec	26	5:30	0	Dec	26	9:50	0	Dec	26	14:11	0
Dec	26	5:35	0	Dec	26	9:56	0	Dec	26	14:16	0
Dec	26	5:40	0	Dec	26	10:01	0	Dec	26	14:22	0
Dec	26	5:45	0	Dec	26	10:06	0	Dec	26	14:27	0
Dec	26	5:50	0	Dec	26	10:11	0	Dec	26	14:32	0
Dec	26	5:55	0	Dec	26	10:16	0	Dec	26	14:37	0
Dec	26	6:00	0	Dec	26	10:21	0	Dec	26	14:42	0
Dec	26	6:05	0	Dec	26	10:26	0	Dec	26	14:47	0
Dec	26	6:10	0	Dec	26	10:31	0	Dec	26	14:52	0
Dec	26	6:16	0	Dec	26	10:36	0	Dec	26	14:57	0
Dec	26	6:21	0	Dec	26	10:42	0	Dec	26	15:02	0
Dec	26	6:26	0	Dec	26	10:47	0	Dec	26	15:08	0
Dec	26	6:31	0	Dec	26	10:52	0	Dec	26	15:13	0
Dec	26	6:36	0	Dec	26	10:57	0	Dec	26	15:18	0
Dec	26	6:41	0	Dec	26	11:02	0	Dec	26	15:23	0
Dec	26	6:46	0	Dec	26	11:07	0	Dec	26	15:28	0
Dec	26	6:51	0	Dec	26	11:12	0	Dec	26	15:33	0
Dec	26	6:56	0	Dec	26	11:17	0	Dec	26	15:38	0
Dec	26	7:02	0	Dec	26	11:22	0	Dec	26	15:43	0
Dec	26	7:07	0	Dec	26	11:28	0	Dec	26	15:48	0
Dec	26	7:12	0	Dec	26	11:33	0	Dec	26	15:54	0
Dec	26	7:17	0	Dec	26	11:38	0	Dec	26	15:59	0
Dec	26	7:22	0	Dec	26	11:43	0	Dec	26	16:04	0

Table A-1. December 24-29, 1998 Storm Distribution

Month	Day	Time	Inches		Month	Day	Time	Inches		Month	Day	Time	Inches
Dec	26	16:09	0		Dec	26	20:30	0		Dec	27	0:51	0
Dec	26	16:14	0		Dec	26	20:35	0		Dec	27	0:56	0
Dec	26	16:19	0		Dec	26	20:40	0		Dec	27	1:01	0
Dec	26	16:24	0		Dec	26	20:45	0		Dec	27	1:06	0
Dec	26	16:29	0		Dec	26	20:50	0		Dec	27	1:11	0
Dec	26	16:35	0		Dec	26	20:55	0		Dec	27	1:16	0
Dec	26	16:40	0		Dec	26	21:01	0		Dec	27	1:21	0
Dec	26	16:45	0		Dec	26	21:06	0		Dec	27	1:27	0
Dec	26	16:50	0		Dec	26	21:11	0		Dec	27	1:32	0
Dec	26	16:55	0		Dec	26	21:16	0		Dec	27	1:37	0
Dec	26	17:00	0		Dec	26	21:21	0		Dec	27	1:42	0
Dec	26	17:05	0		Dec	26	21:26	0		Dec	27	1:47	0
Dec	26	17:10	0		Dec	26	21:31	0		Dec	27	1:52	0
Dec	26	17:15	0		Dec	26	21:36	0		Dec	27	1:57	0
Dec	26	17:21	0		Dec	26	21:41	0		Dec	27	2:02	0
Dec	26	17:26	0		Dec	26	21:47	0		Dec	27	2:07	0
Dec	26	17:31	0		Dec	26	21:52	0		Dec	27	2:13	0
Dec	26	17:36	0		Dec	26	21:57	0		Dec	27	2:18	0
Dec	26	17:41	0		Dec	26	22:02	0		Dec	27	2:23	0
Dec	26	17:46	0		Dec	26	22:07	0		Dec	27	2:28	0
Dec	26	17:51	0		Dec	26	22:12	0		Dec	27	2:33	0
Dec	26	17:56	0		Dec	26	22:17	0		Dec	27	2:38	0
Dec	26	18:01	0		Dec	26	22:22	0		Dec	27	2:43	0
Dec	26	18:07	0		Dec	26	22:27	0		Dec	27	2:48	0
Dec	26	18:12	0		Dec	26	22:33	0		Dec	27	2:53	0
Dec	26	18:17	0		Dec	26	22:38	0		Dec	27	2:59	0
Dec	26	18:22	0		Dec	26	22:43	0		Dec	27	3:04	0
Dec	26	18:27	0		Dec	26	22:48	0		Dec	27	3:09	0
Dec	26	18:32	0		Dec	26	22:53	0		Dec	27	3:14	0
Dec	26	18:37	0		Dec	26	22:58	0		Dec	27	3:19	0
Dec	26	18:42	0		Dec	26	23:03	0		Dec	27	3:24	0
Dec	26	18:48	0		Dec	26	23:08	0		Dec	27	3:29	0
Dec	26	18:53	0		Dec	26	23:14	0		Dec	27	3:34	0
Dec	26	18:58	0		Dec	26	23:19	0		Dec	27	3:40	0
Dec	26	19:03	0		Dec	26	23:24	0		Dec	27	3:45	0
Dec	26	19:08	0		Dec	26	23:29	0		Dec	27	3:50	0
Dec	26	19:13	0		Dec	26	23:34	0		Dec	27	3:55	0
Dec	26	19:18	0		Dec	26	23:39	0		Dec	27	4:00	0.01
Dec	26	19:23	0		Dec	26	23:44	0		Dec	27	4:05	0
Dec	26	19:28	0		Dec	26	23:49	0		Dec	27	4:10	0
Dec	26	19:34	0		Dec	26	23:54	0		Dec	27	4:15	0
Dec	26	19:39	0		Dec	27	0:00	0		Dec	27	4:20	0.01
Dec	26	19:44	0		Dec	27	0:05	0		Dec	27	4:26	0
Dec	26	19:49	0		Dec	27	0:10	0		Dec	27	4:31	0
Dec	26	19:54	0		Dec	27	0:15	0		Dec	27	4:36	0
Dec	26	19:59	0		Dec	27	0:20	0		Dec	27	4:41	0
Dec	26	20:04	0		Dec	27	0:25	0		Dec	27	4:46	0.01
Dec	26	20:09	0		Dec	27	0:30	0		Dec	27	4:51	0
Dec	26	20:14	0		Dec	27	0:35	0		Dec	27	4:56	0
Dec	26	20:20	0		Dec	27	0:40	0		Dec	27	5:01	0
Dec	26	20:25	0		Dec	27	0:46	0		Dec	27	5:06	0

Table A-1. December 24-29, 1998 Storm Distribution

Month	Day	Time	Inches		Month	Day	Time	Inches		Month	Day	Time	Inches
Dec	27	5:12	0		Dec	27	9:32	0		Dec	27	13:53	0.01
Dec	27	5:17	0		Dec	27	9:38	0		Dec	27	13:59	0.02
Dec	27	5:22	0		Dec	27	9:43	0.01		Dec	27	14:04	0
Dec	27	5:27	0		Dec	27	9:48	0		Dec	27	14:09	0.02
Dec	27	5:32	0		Dec	27	9:53	0		Dec	27	14:14	0.01
Dec	27	5:37	0		Dec	27	9:58	0.01		Dec	27	14:19	0.02
Dec	27	5:42	0		Dec	27	10:03	0		Dec	27	14:24	0.01
Dec	27	5:47	0		Dec	27	10:08	0		Dec	27	14:29	0.01
Dec	27	5:53	0.01		Dec	27	10:13	0		Dec	27	14:34	0.02
Dec	27	5:58	0		Dec	27	10:19	0.01		Dec	27	14:39	0.01
Dec	27	6:03	0.01		Dec	27	10:24	0		Dec	27	14:45	0.01
Dec	27	6:08	0		Dec	27	10:29	0.01		Dec	27	14:50	0.02
Dec	27	6:13	0		Dec	27	10:34	0.01		Dec	27	14:55	0.02
Dec	27	6:18	0		Dec	27	10:39	0		Dec	27	15:00	0.02
Dec	27	6:23	0.01		Dec	27	10:44	0.01		Dec	27	15:05	0.01
Dec	27	6:28	0		Dec	27	10:49	0.01		Dec	27	15:10	0.02
Dec	27	6:33	0		Dec	27	10:54	0		Dec	27	15:15	0.02
Dec	27	6:39	0		Dec	27	10:59	0		Dec	27	15:20	0.02
Dec	27	6:44	0		Dec	27	11:05	0.01		Dec	27	15:25	0.02
Dec	27	6:49	0		Dec	27	11:10	0.01		Dec	27	15:31	0.02
Dec	27	6:54	0		Dec	27	11:15	0.01		Dec	27	15:36	0.02
Dec	27	6:59	0.01		Dec	27	11:20	0.01		Dec	27	15:41	0.03
Dec	27	7:04	0		Dec	27	11:25	0.01		Dec	27	15:46	0.04
Dec	27	7:09	0		Dec	27	11:30	0.01		Dec	27	15:51	0.02
Dec	27	7:14	0.01		Dec	27	11:35	0.01		Dec	27	15:56	0.03
Dec	27	7:19	0		Dec	27	11:40	0		Dec	27	16:01	0.03
Dec	27	7:25	0		Dec	27	11:45	0.01		Dec	27	16:06	0.02
Dec	27	7:30	0		Dec	27	11:51	0.01		Dec	27	16:12	0.02
Dec	27	7:35	0.01		Dec	27	11:56	0		Dec	27	16:17	0.02
Dec	27	7:40	0		Dec	27	12:01	0.01		Dec	27	16:22	0.01
Dec	27	7:45	0		Dec	27	12:06	0.02		Dec	27	16:27	0.02
Dec	27	7:50	0		Dec	27	12:11	0.01		Dec	27	16:32	0.01
Dec	27	7:55	0		Dec	27	12:16	0.01		Dec	27	16:37	0.01
Dec	27	8:00	0		Dec	27	12:21	0.02		Dec	27	16:42	0.02
Dec	27	8:06	0		Dec	27	12:26	0.01		Dec	27	16:47	0.02
Dec	27	8:11	0		Dec	27	12:32	0.01		Dec	27	16:52	0.01
Dec	27	8:16	0		Dec	27	12:37	0.01		Dec	27	16:58	0.01
Dec	27	8:21	0		Dec	27	12:42	0.02		Dec	27	17:03	0.01
Dec	27	8:26	0		Dec	27	12:47	0.01		Dec	27	17:08	0.01
Dec	27	8:31	0.01		Dec	27	12:52	0.02		Dec	27	17:13	0.01
Dec	27	8:36	0		Dec	27	12:57	0.01		Dec	27	17:18	0.01
Dec	27	8:41	0		Dec	27	13:02	0.02		Dec	27	17:23	0.01
Dec	27	8:46	0		Dec	27	13:07	0.01		Dec	27	17:28	0
Dec	27	8:52	0		Dec	27	13:12	0.01		Dec	27	17:33	0.01
Dec	27	8:57	0.01		Dec	27	13:18	0.01		Dec	27	17:38	0.01
Dec	27	9:02	0		Dec	27	13:23	0.01		Dec	27	17:44	0.01
Dec	27	9:07	0		Dec	27	13:28	0.01		Dec	27	17:49	0.01
Dec	27	9:12	0		Dec	27	13:33	0.01		Dec	27	17:54	0.02
Dec	27	9:17	0		Dec	27	13:38	0.01		Dec	27	17:59	0.02
Dec	27	9:22	0		Dec	27	13:43	0.01		Dec	27	18:04	0.03
Dec	27	9:27	0		Dec	27	13:48	0.01		Dec	27	18:09	0.02

Table A-1. December 24-29, 1998 Storm Distribution

Month	Day	Time	Inches	Month	Day	Time	Inches	Month	Day	Time	Inches
Dec	27	18:14	0.02	Dec	27	22:35	0	Dec	28	2:56	0.01
Dec	27	18:19	0.03	Dec	27	22:40	0.01	Dec	28	3:01	0.02
Dec	27	18:25	0.03	Dec	27	22:45	0.01	Dec	28	3:06	0.01
Dec	27	18:30	0.02	Dec	27	22:51	0	Dec	28	3:11	0.02
Dec	27	18:35	0.02	Dec	27	22:56	0.01	Dec	28	3:17	0.02
Dec	27	18:40	0.02	Dec	27	23:01	0.01	Dec	28	3:22	0.02
Dec	27	18:45	0.01	Dec	27	23:06	0.01	Dec	28	3:27	0.01
Dec	27	18:50	0.02	Dec	27	23:11	0.01	Dec	28	3:32	0.01
Dec	27	18:55	0.02	Dec	27	23:16	0	Dec	28	3:37	0
Dec	27	19:00	0.02	Dec	27	23:21	0.01	Dec	28	3:42	0.01
Dec	27	19:05	0.02	Dec	27	23:26	0.02	Dec	28	3:47	0.01
Dec	27	19:11	0.01	Dec	27	23:31	0.01	Dec	28	3:52	0
Dec	27	19:16	0.02	Dec	27	23:37	0.01	Dec	28	3:57	0.01
Dec	27	19:21	0.02	Dec	27	23:42	0.01	Dec	28	4:03	0.02
Dec	27	19:26	0.03	Dec	27	23:47	0.01	Dec	28	4:08	0.01
Dec	27	19:31	0.02	Dec	27	23:52	0.02	Dec	28	4:13	0
Dec	27	19:36	0.02	Dec	27	23:57	0.01	Dec	28	4:18	0.02
Dec	27	19:41	0.02	Dec	28	0:02	0.01	Dec	28	4:23	0.02
Dec	27	19:46	0.02	Dec	28	0:07	0.01	Dec	28	4:28	0.01
Dec	27	19:51	0.01	Dec	28	0:12	0.01	Dec	28	4:33	0.02
Dec	27	19:57	0.02	Dec	28	0:17	0.01	Dec	28	4:38	0.02
Dec	27	20:02	0.01	Dec	28	0:23	0.02	Dec	28	4:43	0.02
Dec	27	20:07	0.02	Dec	28	0:28	0.02	Dec	28	4:49	0.01
Dec	27	20:12	0.03	Dec	28	0:33	0.02	Dec	28	4:54	0.01
Dec	27	20:17	0.01	Dec	28	0:38	0.02	Dec	28	4:59	0.02
Dec	27	20:22	0.02	Dec	28	0:43	0.02	Dec	28	5:04	0.02
Dec	27	20:27	0.01	Dec	28	0:48	0.02	Dec	28	5:09	0.02
Dec	27	20:32	0.02	Dec	28	0:53	0.01	Dec	28	5:14	0.01
Dec	27	20:38	0.01	Dec	28	0:58	0.01	Dec	28	5:19	0.02
Dec	27	20:43	0.01	Dec	28	1:04	0.01	Dec	28	5:24	0.02
Dec	27	20:48	0.01	Dec	28	1:09	0.02	Dec	28	5:30	0.02
Dec	27	20:53	0.01	Dec	28	1:14	0.01	Dec	28	5:35	0.01
Dec	27	20:58	0.01	Dec	28	1:19	0.01	Dec	28	5:40	0.01
Dec	27	21:03	0.01	Dec	28	1:24	0.02	Dec	28	5:45	0.01
Dec	27	21:08	0.02	Dec	28	1:29	0.01	Dec	28	5:50	0.02
Dec	27	21:13	0.01	Dec	28	1:34	0.01	Dec	28	5:55	0.01
Dec	27	21:18	0.01	Dec	28	1:39	0.02	Dec	28	6:00	0.02
Dec	27	21:24	0.01	Dec	28	1:44	0.01	Dec	28	6:05	0.02
Dec	27	21:29	0.02	Dec	28	1:50	0.01	Dec	28	6:10	0.01
Dec	27	21:34	0.01	Dec	28	1:55	0.01	Dec	28	6:16	0.02
Dec	27	21:39	0.01	Dec	28	2:00	0.01	Dec	28	6:21	0.01
Dec	27	21:44	0	Dec	28	2:05	0.02	Dec	28	6:26	0
Dec	27	21:49	0.01	Dec	28	2:10	0.01	Dec	28	6:31	0.01
Dec	27	21:54	0.01	Dec	28	2:15	0.02	Dec	28	6:36	0.02
Dec	27	21:59	0	Dec	28	2:20	0.01	Dec	28	6:41	0.01
Dec	27	22:04	0.01	Dec	28	2:25	0.02	Dec	28	6:46	0.02
Dec	27	22:10	0	Dec	28	2:30	0.02	Dec	28	6:51	0.01
Dec	27	22:15	0.01	Dec	28	2:36	0.02	Dec	28	6:56	0.01
Dec	27	22:20	0.01	Dec	28	2:41	0.02	Dec	28	7:02	0
Dec	27	22:25	0	Dec	28	2:46	0.01	Dec	28	7:07	0.01
Dec	27	22:30	0.01	Dec	28	2:51	0.02	Dec	28	7:12	0.01

Table A-1. December 24-29, 1998 Storm Distribution

Month	Day	Time	Inches	Month	Day	Time	Inches	Month	Day	Time	Inches
Dec	28	7:17	0	Dec	28	11:38	0.02	Dec	28	15:59	0.01
Dec	28	7:22	0.02	Dec	28	11:43	0.01	Dec	28	16:04	0.01
Dec	28	7:27	0	Dec	28	11:48	0.01	Dec	28	16:09	0.01
Dec	28	7:32	0.01	Dec	28	11:53	0.01	Dec	28	16:14	0.01
Dec	28	7:37	0.01	Dec	28	11:58	0.01	Dec	28	16:19	0.01
Dec	28	7:43	0.01	Dec	28	12:03	0.01	Dec	28	16:24	0.01
Dec	28	7:48	0.01	Dec	28	12:09	0.01	Dec	28	16:29	0.01
Dec	28	7:53	0.01	Dec	28	12:14	0	Dec	28	16:35	0.01
Dec	28	7:58	0	Dec	28	12:19	0.01	Dec	28	16:40	0.01
Dec	28	8:03	0.01	Dec	28	12:24	0.01	Dec	28	16:45	0.01
Dec	28	8:08	0.01	Dec	28	12:29	0.01	Dec	28	16:50	0
Dec	28	8:13	0	Dec	28	12:34	0.01	Dec	28	16:55	0.01
Dec	28	8:18	0.01	Dec	28	12:39	0.01	Dec	28	17:00	0.01
Dec	28	8:23	0.01	Dec	28	12:44	0	Dec	28	17:05	0.01
Dec	28	8:29	0.02	Dec	28	12:49	0.01	Dec	28	17:10	0.01
Dec	28	8:34	0	Dec	28	12:55	0.01	Dec	28	17:15	0.01
Dec	28	8:39	0.01	Dec	28	13:00	0.01	Dec	28	17:21	0.01
Dec	28	8:44	0.01	Dec	28	13:05	0	Dec	28	17:26	0
Dec	28	8:49	0.01	Dec	28	13:10	0.01	Dec	28	17:31	0.01
Dec	28	8:54	0.01	Dec	28	13:15	0.01	Dec	28	17:36	0.01
Dec	28	8:59	0.01	Dec	28	13:20	0	Dec	28	17:41	0.01
Dec	28	9:04	0.01	Dec	28	13:25	0.01	Dec	28	17:46	0
Dec	28	9:09	0	Dec	28	13:30	0	Dec	28	17:51	0.01
Dec	28	9:15	0.01	Dec	28	13:35	0.01	Dec	28	17:56	0.01
Dec	28	9:20	0.01	Dec	28	13:41	0.01	Dec	28	18:01	0
Dec	28	9:25	0	Dec	28	13:46	0.01	Dec	28	18:07	0.01
Dec	28	9:30	0	Dec	28	13:51	0.01	Dec	28	18:12	0.01
Dec	28	9:35	0.01	Dec	28	13:56	0	Dec	28	18:17	0.01
Dec	28	9:40	0	Dec	28	14:01	0.01	Dec	28	18:22	0.01
Dec	28	9:45	0	Dec	28	14:06	0	Dec	28	18:27	0.01
Dec	28	9:50	0.01	Dec	28	14:11	0.01	Dec	28	18:32	0
Dec	28	9:56	0	Dec	28	14:16	0	Dec	28	18:37	0.01
Dec	28	10:01	0.01	Dec	28	14:22	0	Dec	28	18:42	0.01
Dec	28	10:06	0.01	Dec	28	14:27	0.01	Dec	28	18:48	0.01
Dec	28	10:11	0.01	Dec	28	14:32	0	Dec	28	18:53	0.01
Dec	28	10:16	0	Dec	28	14:37	0.01	Dec	28	18:58	0.01
Dec	28	10:21	0.01	Dec	28	14:42	0	Dec	28	19:03	0.01
Dec	28	10:26	0.01	Dec	28	14:47	0.01	Dec	28	19:08	0.01
Dec	28	10:31	0.01	Dec	28	14:52	0	Dec	28	19:13	0.01
Dec	28	10:36	0	Dec	28	14:57	0.01	Dec	28	19:18	0.02
Dec	28	10:42	0.01	Dec	28	15:02	0	Dec	28	19:23	0.01
Dec	28	10:47	0.01	Dec	28	15:08	0.01	Dec	28	19:28	0.01
Dec	28	10:52	0.01	Dec	28	15:13	0	Dec	28	19:34	0
Dec	28	10:57	0.02	Dec	28	15:18	0.01	Dec	28	19:39	0.01
Dec	28	11:02	0	Dec	28	15:23	0	Dec	28	19:44	0.01
Dec	28	11:07	0.01	Dec	28	15:28	0.01	Dec	28	19:49	0
Dec	28	11:12	0.01	Dec	28	15:33	0.01	Dec	28	19:54	0.01
Dec	28	11:17	0.01	Dec	28	15:38	0.01	Dec	28	19:59	0
Dec	28	11:22	0.01	Dec	28	15:43	0.01	Dec	28	20:04	0.01
Dec	28	11:28	0.01	Dec	28	15:48	0.01	Dec	28	20:09	0
Dec	28	11:33	0.01	Dec	28	15:54	0.02	Dec	28	20:14	0

Table A-1. December 24-29, 1998 Storm Distribution

Month	Day	Time	Inches		Month	Day	Time	Inches		Month	Day	Time	Inches
Dec	28	20:20	0.01		Dec	29	0:40	0		Dec	29	5:01	0
Dec	28	20:25	0		Dec	29	0:46	0		Dec	29	5:06	0
Dec	28	20:30	0		Dec	29	0:51	0		Dec	29	5:12	0
Dec	28	20:35	0.01		Dec	29	0:56	0		Dec	29	5:17	0
Dec	28	20:40	0		Dec	29	1:01	0		Dec	29	5:22	0
Dec	28	20:45	0		Dec	29	1:06	0		Dec	29	5:27	0
Dec	28	20:50	0		Dec	29	1:11	0		Dec	29	5:32	0
Dec	28	20:55	0		Dec	29	1:16	0		Dec	29	5:37	0
Dec	28	21:01	0		Dec	29	1:21	0		Dec	29	5:42	0
Dec	28	21:06	0		Dec	29	1:27	0		Dec	29	5:47	0
Dec	28	21:11	0		Dec	29	1:32	0		Dec	29	5:53	0
Dec	28	21:16	0		Dec	29	1:37	0		Dec	29	5:58	0
Dec	28	21:21	0		Dec	29	1:42	0		Dec	29	6:03	0
Dec	28	21:26	0		Dec	29	1:47	0		Dec	29	6:08	0
Dec	28	21:31	0		Dec	29	1:52	0		Dec	29	6:13	0
Dec	28	21:36	0		Dec	29	1:57	0		Dec	29	6:18	0
Dec	28	21:41	0		Dec	29	2:02	0		Dec	29	6:23	0
Dec	28	21:47	0.01		Dec	29	2:07	0		Dec	29	6:28	0
Dec	28	21:52	0		Dec	29	2:13	0		Dec	29	6:33	0
Dec	28	21:57	0		Dec	29	2:18	0		Dec	29	6:39	0
Dec	28	22:02	0		Dec	29	2:23	0		Dec	29	6:44	0
Dec	28	22:07	0		Dec	29	2:28	0		Dec	29	6:49	0
Dec	28	22:12	0		Dec	29	2:33	0		Dec	29	6:54	0
Dec	28	22:17	0		Dec	29	2:38	0		Dec	29	6:59	0
Dec	28	22:22	0		Dec	29	2:43	0		Dec	29	7:04	0
Dec	28	22:27	0		Dec	29	2:48	0		Dec	29	7:09	0
Dec	28	22:33	0		Dec	29	2:53	0		Dec	29	7:14	0
Dec	28	22:38	0		Dec	29	2:59	0		Dec	29	7:19	0
Dec	28	22:43	0		Dec	29	3:04	0		Dec	29	7:25	0
Dec	28	22:48	0		Dec	29	3:09	0		Dec	29	7:30	0
Dec	28	22:53	0		Dec	29	3:14	0		Dec	29	7:35	0
Dec	28	22:58	0		Dec	29	3:19	0		Dec	29	7:40	0
Dec	28	23:03	0		Dec	29	3:24	0		Dec	29	7:45	0
Dec	28	23:08	0		Dec	29	3:29	0		Dec	29	7:50	0
Dec	28	23:14	0		Dec	29	3:34	0		Dec	29	7:55	0
Dec	28	23:19	0		Dec	29	3:40	0		Dec	29	8:00	0
Dec	28	23:24	0		Dec	29	3:45	0		Dec	29	8:06	0
Dec	28	23:29	0		Dec	29	3:50	0		Dec	29	8:11	0
Dec	28	23:34	0		Dec	29	3:55	0		Dec	29	8:16	0
Dec	28	23:39	0		Dec	29	4:00	0		Dec	29	8:21	0
Dec	28	23:44	0		Dec	29	4:05	0		Dec	29	8:26	0
Dec	28	23:49	0		Dec	29	4:10	0		Dec	29	8:31	0
Dec	28	23:54	0		Dec	29	4:15	0		Dec	29	8:36	0
Dec	29	0:00	0		Dec	29	4:20	0		Dec	29	8:41	0
Dec	29	0:05	0		Dec	29	4:26	0		Dec	29	8:46	0
Dec	29	0:10	0		Dec	29	4:31	0		Dec	29	8:52	0
Dec	29	0:15	0		Dec	29	4:36	0		Dec	29	8:57	0
Dec	29	0:20	0		Dec	29	4:41	0		Dec	29	9:02	0
Dec	29	0:25	0		Dec	29	4:46	0		Dec	29	9:07	0
Dec	29	0:30	0		Dec	29	4:51	0		Dec	29	9:12	0
Dec	29	0:35	0		Dec	29	4:56	0		Dec	29	9:17	0

Table A-1. December 24-29, 1998 Storm Distribution

Month	Day	Time	Inches		Month	Day	Time	Inches		Month	Day	Time	Inches
Dec	29	9:22	0										
Dec	29	9:27	0										
Dec	29	9:32	0										
Dec	29	9:38	0										
Dec	29	9:43	0										
Dec	29	9:48	0										
Dec	29	9:53	0										
Dec	29	9:58	0										
Dec	29	10:03	0										
Dec	29	10:08	0										
Dec	29	10:13	0										
Dec	29	10:19	0										
Dec	29	10:24	0										
Dec	29	10:29	0										
Dec	29	10:34	0										
Dec	29	10:39	0										
Dec	29	10:44	0										
Dec	29	10:49	0										
Dec	29	10:54	0										
Dec	29	10:59	0										
Dec	29	11:05	0										
Dec	29	11:10	0										
Dec	29	11:15	0										
Dec	29	11:20	0										
Dec	29	11:25	0.01										
Dec	29	11:30	0										
Dec	29	11:35	0										
Dec	29	11:40	0										
Dec	29	11:45	0										
Dec	29	11:51	0										
Dec	29	11:56	0										
Dec	29	12:01	0										

TABLE A-2

SUBBASIN CHARACTERISTICS

Table A-2. Subbasin Characteristics

Basin	Subbasin	Runoff Node	Area	Slope	Width	Present Impervious	Future Impervious
Dixon	DIX010B	DIX410N	28.83	0.091	2850	24.89	25.30
Dixon	DIX020B	DIX415N	69.73	0.097	6000	23.82	25.30
Dixon	DIX030B	DIX375N	13.66	0.134	1775	22.76	25.30
Dixon	DIX040B	DIX385N	57.83	0.102	3250	20.19	20.19
Dixon	DIX050B	DIX390N	47.49	0.128	3775	13.50	13.50
Dixon	DIX180B	DIX235N	25.71	0.001	1450	45.71	51.62
Dixon	DIX190B	DIX245N	33.24	0.002	3525	42.96	62.54
Dixon	DIX200B	DIX225N	45.02	0.002	3350	43.01	61.38
Dixon	DIX210B	DIX225N	66.64	0.002	5375	42.07	74.27
Dixon	DIX215B	DIX515N	12.93	0.004	2000	34.58	40.12
Dixon	DIX220B	DIX525N	60.28	0.003	6375	28.93	29.48
Dixon	DIX225B	DIX505N	9.25	0.002	650	47.77	47.87
Dixon	DIX230B	DIX520N	37.41	0.001	2400	48.09	48.41
Dixon	DIX240B	DIX290N	131.15	0.010	7250	41.07	41.38
Dixon	DIX242B	DIX340N	68.18	0.094	4200	23.59	24.25
Dixon	DIX250B	DIX535N	4.85	0.003	675	19.39	25.30
Dixon	DIX260B	DIX535N	4.97	0.003	525	20.45	25.30
Dixon	DIX270B	DIX545N	8.27	0.003	1050	24.90	25.30
Dixon	DIX280B	DIX560N	14.09	0.003	1775	24.45	25.30
Dixon	DIX290B	DIX560N	16.66	0.016	2375	25.23	25.38
Dixon	DIX300B	DIX560N	31.55	0.006	1600	25.07	25.07
Dixon	DIX310B	DIX565N	42.31	0.010	3525	24.96	25.07
Dixon	DIX320B	DIX575N	9.19	0.005	1975	25.30	25.30
Dixon	DIX325B	DIX580N	20.02	0.002	1650	49.70	49.70
Dixon	DIX330B	DIX575N	122.68	0.204	10550	25.93	26.42
Dixon	DIX340B	DIX420N	17.96	0.019	1500	30.08	30.08
Dixon	DIX342B	DIX435N	36.19	0.048	5000	41.35	58.33
Dixon	DIX344B	DIX465N	30.47	0.127	950	21.76	42.35
Dixon	DIX350B	DIX360N	16.32	0.055	1550	34.53	34.53
Dixon	DIX352B	DIX400N	15.90	0.051	1175	25.30	25.30
Dixon	DIX360B	DIX610N	14.93	0.087	1250	24.75	25.30
Dixon	DIX370B	DIX610N	6.48	0.064	900	25.30	25.30
Dixon	DIX375B	DIX613N	19.13	0.035	1150	23.30	25.93
Dixon	DIX380B	DIX620N	4.73	0.004	775	25.30	25.30
Dixon	DIX390B	DIX625N	19.64	0.157	1925	22.75	25.30
Dixon	DIX400B	DIX625N	9.72	0.028	775	20.24	26.46
Dixon	DIX410B	DIX640N	21.28	0.116	725	28.77	41.94
Dixon	DIX420B	DIX645N	19.18	0.122	775	27.66	33.35
Dixon	DIX430B	DIX655N	41.33	0.138	1875	21.88	39.85
Dixon	DIX440B	DIX660N	77.37	0.156	3600	27.42	29.63
Dixon	DIX450B	DIX660N	204.81	0.229	9025	23.62	23.62
Dixon	DIX460B	DIX675N	3.39	0.015	450	20.79	35.24
Dixon	DIX470B	DIX695N	3.48	0.035	525	21.36	35.36
Dixon	DIX480B	DIX355N	45.25	0.099	2675	7.13	30.85
Dixon	DIX490B	DIX698N	9.36	0.027	540	19.98	31.01
Dixon	DIX500B	DIX698N	14.59	0.014	1600	21.59	25.73
Dixon	DIX510B	DIX705N	7.96	0.040	1200	22.36	22.90
Dixon	DIX520B	DIX700N	5.30	0.083	950	21.71	23.18
Dixon	DIX530B	DIX785N	19.58	0.073	1475	18.44	18.44
Dixon	DIX540B	DIX790N	8.57	0.125	775	18.30	18.30

Table A-2. Subbasin Characteristics

Basin	Subbasin	Runoff Node	Area	Slope	Width	Present Impervious	Future Impervious
Dixon	DIX550B	DIX785N	3.91	0.059	675	9.52	9.66
Dixon	DIX560B	DIX710N	3.93	0.091	625	16.24	17.45
Dixon	DIX570B	DIX735N	2.22	0.060	1070	4.05	4.05
Dixon	DIX580B	DIX715N	8.01	0.077	875	10.61	15.40
Dixon	DIX590B	DIX740N	2.38	0.045	925	3.96	3.96
Dixon	DIX600B	DIX735N	14.43	0.084	900	21.72	21.72
Dixon	DIX610B	DIX800N	27.69	0.143	2875	7.14	23.24
Dixon	DIX620B	DIX745N	6.90	0.123	425	20.27	20.40
Dixon	DIX630B	DIX760N	3.20	0.092	525	3.48	3.48
Dixon	DIX640B	DIX720N	16.47	0.079	2350	10.08	19.86
Dixon	DIX650B	DIX725N	10.56	0.150	350	3.28	29.93
Dixon	DIX660B	DIX730N	76.12	0.169	3725	2.30	8.10
Dixon	DIX670B	DIX755N	94.70	0.199	4550	1.78	7.15
Dixon	DIX680B	DIX780N	18.42	0.163	1350	5.23	9.94
Dixon	DIX690B	DIX665N	1.79	0.006	450	23.97	25.30
Dixon	DIX700B	DIX635N	8.92	0.093	650	24.24	25.30
Dixon	DIX710B	DIX810N	16.84	0.195	1675	27.21	27.96
Dixon	DIX720B	DIX810N	27.03	0.007	1750	31.87	36.45
Dixon	DIX730B	DIX815N	15.62	0.224	2950	25.06	27.78
Dixon	DIX740B	DIX825N	12.36	0.206	1450	18.59	25.30
Dixon	DIX750B	DIX830N	48.64	0.075	3625	20.09	27.93
Dixon	DIX760B	DIX835N	73.11	0.157	8600	18.37	22.72
Dixon	DIX770B	DIX840N	24.35	0.133	4100	19.55	27.31
Dixon	DIX780B	DIX840N	3.46	0.036	275	31.51	35.36
Dixon	DIX790B	DIX850N	3.70	0.030	325	35.36	35.36
Dixon	DIX800B	DIX855N	11.85	0.128	1100	22.30	26.07
Dixon	DIX810B	DIX860N	40.24	0.070	1225	13.26	25.30
Dixon	DIX820B	DIX850N	12.65	0.156	1375	20.16	28.02
Dixon	DIX830B	DIX860N	4.11	0.164	500	29.61	30.67
Dixon	DIX840B	DIX860N	8.64	0.113	475	23.24	25.30
Dixon	DIX850B	DIX870N	6.24	0.208	750	9.66	25.34
Dixon	DIX860B	DIX865N	15.86	0.166	575	22.37	25.30
Dixon	DIX870B	DIX885N	19.07	0.239	975	11.04	19.12
Dixon	DIX880B	DIX874N	10.18	0.144	950	5.47	25.30
Dixon	DIX890B	DIX880N	10.61	0.116	950	3.16	25.30
Dixon	DIX895B	DIX885N	2.78	0.066	325	15.49	25.30
Dixon	DIX900B	DIX915N	6.85	0.261	525	1.52	2.16
Dixon	DIX910B	DIX925N	23.83	0.215	1800	1.42	6.03
Dixon	DIX920B	DIX900N	8.00	0.055	650	12.22	24.39
Dixon	DIX930B	DIX945N	5.51	0.116	350	16.37	25.30
Dixon	DIX940B	DIX910N	14.35	0.170	1500	3.06	10.22
Dixon	DIX950B	DIX940N	21.22	0.200	1625	4.11	15.17
Dixon	DIX960B	DIX955N	10.30	0.116	1300	12.75	18.46
Dixon	DIX970B	DIX975N	4.89	0.176	300	1.17	1.17
Dixon	DIX980B	DIX995N	34.57	0.174	2200	1.12	1.12
Dixon	DIX990B	DIX930N	249.51	0.257	10000	1.12	1.12
Squaw	SQW005B	SQW260N	467.51	0.075	7931	20.14	21.53
Squaw	SQW010B	SQW150N	118.15	0.046	2695	20.07	22.28
Squaw	SQW015B	SQW150N	95.79	0.057	1931	14.30	28.48
Squaw	SQW020B	SQW075N	106.84	0.023	2433	21.10	25.59

Table A-2. Subbasin Characteristics

Basin	Subbasin	Runoff Node	Area	Slope	Width	Present Impervious	Future Impervious
Squaw	SQW025B	SQW085N	48.34	0.018	2269	15.60	48.21
Squaw	SQW030B	SQW265N	83.73	0.044	3328	10.97	24.48
Squaw	SQW035B	SQW155N	78.73	0.069	2894	9.99	9.99
Squaw	SQW040B	SQW160N	71.29	0.089	1935	30.73	36.56
Squaw	SQW045B	SQW165N	57.03	0.079	1151	6.87	6.91
Squaw	SQW050B	SQW006N	15.34	0.010	1777	16.27	16.43
Squaw	SQW055B	SQW010N	53.33	0.080	3267	23.44	23.44
Squaw	SQW060B	SQW030N	53.91	0.098	2393	20.60	21.09
Squaw	SQW065B	SQW021N	30.67	0.018	2667	50.36	50.36
Squaw	SQW070B	SQW000N	32.35	0.013	959	55.19	55.19
Squaw	SQW075B	SQW035N	32.93	0.016	2570	20.09	20.09
Squaw	SQW080B	SQW235N	45.45	0.010	1908	20.78	23.93
Squaw	SQW085B	SQW035N	55.26	0.016	2258	19.87	33.00
Squaw	SQW090B	SQW250N	95.94	0.012	2670	5.47	43.79
Squaw	SQW095B	SQW250N	141.23	0.031	3699	11.28	26.49
Squaw	SQW100B	SQW085N	14.84	0.013	1038	27.89	42.00
Squaw	SQW105B	SQW195N	12.46	0.021	2320	26.93	65.36
Squaw	SQW110B	SQW040N	45.18	0.022	3065	11.35	35.21
Squaw	SQW115B	SQW120N	35.93	0.025	3027	20.21	33.24
Squaw	SQW120B	SQW050N	81.22	0.068	2365	17.04	17.04
Squaw	SQW125B	SQW085N	52.78	0.012	3775	36.61	55.41
Squaw	SQW130B	SQW060N	55.81	0.010	4184	27.15	29.26
Squaw	SQW135B	SQW060N	11.82	0.014	1769	14.47	43.52
Squaw	SQW140B	SQW205N	44.32	0.060	2321	24.22	25.73
Squaw	SQW145B	SQW145N	132.95	0.041	3705	23.95	37.75
Squaw	SQW150B	SQW260N	78.42	0.053	2416	15.00	39.03
Squaw	SQW155B	SQW045N	113.53	0.094	3743	8.94	8.94
North	NOR010B	NOR035N	243.42	0.154	2050	1.12	1.12
North	NOR020B	NOR035N	253.65	0.133	2600	1.12	1.12
North	NOR030B	NOR030N	316.38	0.122	3800	3.65	4.62
North	NOR040B	NOR025N	201.17	0.138	6125	7.47	12.77
North	NOR050B	NOR005N	39.00	0.006	1700	12.19	14.38
North	NOR060B	NOR070N	417.48	0.059	7025	4.63	10.19
North	NOR070B	NOR095N	210.39	0.192	3900	1.13	1.14
North	NOR080B	NOR005N	169.80	0.028	5650	24.42	31.00
North	NOR090B	NOR060N	175.61	0.152	4950	10.65	27.41
North	NOR100B	NOR075N	72.71	0.165	2550	8.68	22.50
North	NOR110B	NOR080N	423.65	0.159	4400	1.50	2.32
North	NOR120B	NOR090N	155.94	0.317	4250	1.31	2.58
North	NOR130B	NOR010N	108.51	0.225	2650	11.98	27.27
North	NOR140B	NOR000N	236.67	0.084	6425	24.21	28.44
North	NOR150B	NOR050N	166.75	0.126	5100	21.20	26.91
North	NOR160B	NOR060N	207.07	0.024	4050	39.20	39.82
North	NOR170B	NOR085N	132.14	0.138	2575	3.44	18.87
North	NOR180B	NOR005N	154.28	0.047	2850	6.07	23.15
North	NOR190B	NOR050N	83.43	0.009	3325	18.28	22.44
North	NOR200B	NOR015N	167.59	0.024	7550	16.21	23.79
North	NOR210B	NOR007N	116.21	0.061	3800	37.02	40.44
Village Green	VLG100B	VLG040N	26.54	0.010	600	13.85	13.85
Village Green	VLG200B	VLG035N	32.28	0.013	1350	40.45	42.11

Table A-2. Subbasin Characteristics

Basin	Subbasin	Runoff Node	Area	Slope	Width	Present Impervious	Future Impervious
Village Green	VLG300B	VLG035N	7.37	0.012	925	43.60	46.19
Village Green	VLG400B	VLG040N	76.89	0.009	2350	19.45	19.45
Village Green	VLG500B	VLG025N	23.10	0.006	750	35.41	35.82
Village Green	VLG600B	VLG025N	29.82	0.012	2150	35.39	43.59
Village Green	VLG700B	VLG015N	61.74	0.007	2975	29.31	31.97
Village Green	VLG800B	VLG010N	57.00	0.006	3225	36.67	36.77
Village Green	VLG900B	VLG000N	65.23	0.005	4150	18.91	18.91
Sequoia	SEQ005B	SEQ345N	184.71	0.130	4560	23.80	25.14
Sequoia	SEQ010B	SEQ185N	71.34	0.076	7320	26.57	39.62
Sequoia	SEQ015B	SEQ150N	79.57	0.086	5080	34.70	50.10
Sequoia	SEQ020B	SEQ140N	20.99	0.098	1820	24.78	28.61
Sequoia	SEQ025B	SEQ120N	54.75	0.010	4250	35.01	40.54
Sequoia	SEQ030B	SEQ305N	23.90	0.118	3140	23.91	26.29
Sequoia	SEQ035B	SEQ385N	9.65	0.097	1225	21.74	26.55
Sequoia	SEQ040B	SEQ255N	23.79	0.146	910	21.76	29.28
Sequoia	SEQ045B	SEQ260N	62.31	0.157	2240	16.23	27.33
Sequoia	SEQ050B	SEQ170N	34.07	0.012	5000	27.75	27.75
Sequoia	SEQ055B	SEQ160N	84.40	0.003	6460	37.45	65.69
Sequoia	SEQ060B	SEQ100N	59.22	0.004	2790	36.87	53.70
Sequoia	SEQ065B	SEQ005N	233.00	0.006	3400	11.57	15.47
Sequoia	SEQ070B	SEQ205N	66.27	0.002	3010	38.85	39.30
Sequoia	SEQ075B	SEQ200N	108.91	0.031	9070	35.14	35.43
Sequoia	SEQ080B	SEQ195N	23.73	0.014	1920	25.78	25.78
Sequoia	SEQ085B	SEQ080N	34.83	0.005	1921	21.20	73.58
Sequoia	SEQ090B	SEQ025N	45.00	0.009	2533	29.96	48.12
Sequoia	SEQ095B	SEQ335N	15.67	0.136	1000	22.70	25.30
Sequoia	SEQ100B	SEQ285N	18.69	0.156	1260	17.97	30.73
Sequoia	SEQ105B	SEQ325N	12.67	0.078	1075	24.13	25.30
Sequoia	SEQ110B	SEQ290N	21.79	0.053	1000	24.03	30.24
Sequoia	SEQ115B	SEQ365N	17.53	0.023	1400	36.54	36.54
Sequoia	SEQ120B	SEQ345N	12.25	0.091	1150	23.29	25.30
Sequoia	SEQ125B	SEQ390N	37.92	0.113	1275	21.85	23.94
Garfield	GAR010B	GAR010N	150.97	0.011	3580	39.48	47.26
Garfield	GAR025B	GAR025N	62.56	0.010	1375	45.83	47.85
Garfield	GAR030B	GAR030N	5.14	0.025	930	46.48	81.15
Garfield	GAR055A	GAR055N	16.99	0.004	1560	44.32	76.66
Garfield	GAR055B	GAR055N	17.04	0.004	2490	46.48	81.15
Garfield	GAR075B	GAR075N	33.62	0.003	1865	37.68	37.68
Garfield	GAR090B	GAR090N	8.79	0.005	950	45.82	59.96
Garfield	GAR095B	GAR095N	5.33	0.004	1365	40.13	41.52
Garfield	GAR105B	GAR105N	7.65	0.004	1100	44.29	74.77
Garfield	GAR130B	GAR130N	17.37	0.004	1735	28.95	65.89
Garfield	GAR140B	GAR140N	6.16	0.004	1000	46.56	46.77
Garfield	GAR150B	GAR150N	13.94	0.004	2100	54.14	54.14
Oak	OAK005B	OAK205N	1562.41	0.144	12125	1.12	1.12
Oak	OAK010B	OAK215N	432.10	0.160	8575	1.12	1.12
Oak	OAK015B	OAK150N	810.41	0.086	12000	1.51	1.51
Oak	OAK020B	OAK170N	728.17	0.161	11875	1.92	2.96
Oak	OAK025B	OAK230N	260.85	0.172	5775	5.22	15.61
Oak	OAK030B	OAK240N	38.63	0.183	1150	5.81	5.81

Table A-2. Subbasin Characteristics

Basin	Subbasin	Runoff Node	Area	Slope	Width	Present Impervious	Future Impervious
Oak	OAK035B	OAK100N	254.88	0.035	3675	9.35	18.60
Oak	OAK040B	OAK100N	122.06	0.022	2600	8.66	8.66
Oak	OAK045B	OAK090N	217.88	0.030	5475	11.05	21.78
Oak	OAK050B	OAK060N	73.67	0.041	1675	44.46	47.76
Oak	OAK055B	OAK010N	48.80	0.010	1575	54.70	56.19
Oak	OAK060B	OAK025N	45.97	0.013	1175	26.08	26.18
Oak	OAK065B	OAK260N	50.38	0.010	1350	45.62	52.12
Oak	OAK070B	OAK145N	33.42	0.031	1750	39.49	39.49
Oak	OAK075B	OAK020N	33.15	0.015	900	54.59	54.59
Oak	OAK080B	OAK030N	13.46	0.017	630	58.11	58.11
Oak	OAK085B	OAK035N	24.91	0.008	1275	56.90	56.90
Oak	OAK090B	OAK205N	2352.12	0.267	15000	1.12	1.12
Oak	OAK100B	OAK045N	26.73	0.025	1275	54.81	54.81
Oak	OAK105B	OAK310N	88.47	0.010	2725	58.57	58.57
Oak	OAK110B	OAK375N	92.38	0.015	3550	22.85	29.57
Oak	OAK115B	OAK395N	18.61	0.006	2542	58.57	58.57
Oak	OAK120B	OAK280N	20.88	0.177	1275	6.56	6.56
Oak	OAK125B	OAK290N	573.92	0.171	12125	6.86	12.96
Oak	OAK130B	OAK285N	66.57	0.181	1775	5.81	5.81
Oak	OAK135B	OAK245N	104.65	0.110	3000	8.89	12.22
Oak	OAK140B	OAK235N	34.38	0.131	1725	5.57	5.65
Oak	OAK145B	OAK250N	46.33	0.158	1175	5.81	5.81
Oak	OAK150B	OAK120N	31.60	0.047	1400	5.81	5.81
Oak	OAK155B	OAK120N	33.21	0.007	1025	5.81	5.81
Oak	OAK160B	OAK380N	37.65	0.015	2391	58.57	58.57
Oak	OAK165B	OAK410N	29.38	0.013	1346	51.11	51.15
Marys River	MRY001B	MRY001N	43.65	0.092	1025	5.97	18.23
Marys River	MRY002B	MRY003N	23.16	0.088	650	16.77	25.30
Marys River	MRY003B	MRY005N	11.64	0.107	570	23.43	25.30
Goodnight	GDN015B	GDN015N	47.55	0.010	1600	7.22	32.29
Goodnight	GDN030B	GDN030N	7.96	0.010	1875	18.37	23.99
Goodnight	GDN045B	GDN045N	1.52	0.008	320	35.21	35.21
Goodnight	GDN050B	GDN050N	6.41	0.005	1075	24.31	25.30
Goodnight	GDN055B	GDN055N	12.75	0.005	1050	26.92	29.10
Goodnight	GDN060B	GDN060N	8.75	0.005	1075	16.94	25.30
Goodnight	GDN075B	GDN075N	46.71	0.005	4100	25.47	34.23
Goodnight	GDN090B	GDN090N	23.05	0.005	1500	34.73	35.35
Goodnight	GDN100B	GDN100N	11.48	0.005	1600	24.40	25.40
Goodnight	GDN140B	GDN140N	10.80	0.005	2000	25.26	25.45
Goodnight	GDN150B	GDN150N	0.70	0.005	50	25.30	25.30
Goodnight	GDN160B	GDN160N	5.67	0.005	1200	25.30	25.30
Goodnight	GDN165B	GDN165N	0.72	0.005	50	25.30	26.90
Goodnight	GDN185B	GDN185N	11.27	0.030	1000	3.16	9.23
Goodnight	GDN500B	GDN500N	0.78	0.008	300	17.80	25.30
Goodnight	GDN520B	GDN520N	5.41	0.008	1080	10.26	25.15
Goodnight	GDN535B	GDN535N	3.47	0.008	700	3.37	25.41
Goodnight	GDN550B	GDN550N	4.03	0.008	440	3.23	30.76
Goodnight	GDN555B	GDN555N	22.23	0.015	1200	3.16	40.23
Goodnight	GDN565B	GDN565N	5.91	0.015	920	3.26	35.28
Goodnight	GDN570B	GDN570N	26.27	0.005	925	3.17	35.36

Table A-2. Subbasin Characteristics

Basin	Subbasin	Runoff Node	Area	Slope	Width	Present Impervious	Future Impervious
Goodnight	GDN575B	GDN575N	19.17	0.005	700	3.73	35.36
Goodnight	GDN585B	GDN585N	15.57	0.005	500	19.47	36.46
Millrace	MIL005B	MIL005N	19.14	0.005	1425	26.60	37.94
Millrace	MIL030B	MIL030N	19.30	0.005	1325	23.57	26.63
Millrace	MIL040B	MIL035N	83.86	0.005	2475	33.33	59.67
Millrace	MIL055B	MIL055N	79.35	0.011	4300	32.37	39.20
Millrace	MIL060B	MIL060N	19.46	0.005	1200	29.93	62.27
Millrace	MIL075B	MIL075N	70.96	0.005	2650	40.49	45.12
Millrace	MIL080B	MIL080N	28.88	0.005	1025	5.76	5.76
Millrace	MIL085B	MIL085N	27.58	0.005	750	5.58	5.58

Recommendations: Given relatively favorable existing conditions, fairly minimal structural improvements and planting efforts could potentially enhance salmonid holding and spawning habitat in the upper reaches of Oak Creek. The upstream area reportedly contains cutthroat trout and conditions could readily be improved for this species. Fully functional channel and floodplain conditions, along with the establishment of a wide woody riparian corridor and stream buffer, could also be achieved with little or no infrastructure impact in this area. These generally favorable (and readily improvable) channel and riparian conditions in the upstream reaches of Oak Creek provides a strong incentive to prioritize removal of all fish passage barriers between Oak Creek's headwaters and its confluence with the Mary's River.

TABLE A-3

CLOSED CONDUIT PARAMETERS

Table A-3. Closed Conduit Parameters

Basin	Name	Upstream Node	Downstream Node	Conduit Type	US Invert Elev., ft	DS Invert Elev., ft	Length, ft	Circular Dia, ft	Mannings Roughness	Box Depth, ft	Box Width, ft	No. of conduits
Dixon	DIX225L	DIX225N	DIX220N	BRIDGE	207.50	207.00	140	0.00	0.013	20.00	16.00	1
Dixon	DIX235L	DIX235N	DIX230N	BRIDGE	203.50	203.00	150	0.00	0.013	7.60	23.00	1
Dixon	DIX245L	DIX245N	DIX240N	BRIDGE	204.30	204.00	62	0.00	0.013	7.50	17.00	1
Dixon	DIX255L	DIX255N	DIX250N	BRIDGE	205.00	204.50	150	0.00	0.013	8.70	23.00	1
Dixon	DIX475L	DIX475N	DIX470N	BRIDGE	198.00	197.50	91	0.00	0.013	11.50	8.00	1
Dixon	DIX485L	DIX485N	DIX480N	BRIDGE	206.40	206.00	56	0.00	0.013	5.70	21.00	1
Dixon	DIX495L	DIX495N	DIX490N	BRIDGE	211.60	211.00	32	0.00	0.013	6.50	20.80	1
Dixon	DIX505L	DIX505N	DIX500N	BRIDGE	213.30	213.00	124	0.00	0.013	6.80	18.00	1
Dixon	DIX515L	DIX515N	DIX510N	BRIDGE	214.00	213.80	47	0.00	0.013	10.00	11.00	1
Dixon	DIX525L	DIX525N	DIX520N	BRIDGE	214.50	214.30	64	0.00	0.013	8.00	18.10	1
Dixon	DIX535L	DIX535N	DIX530N	BRIDGE	216.30	216.00	70	0.00	0.013	7.90	18.10	1
Dixon	DIX545L	DIX545N	DIX540N	BRIDGE	218.80	218.30	55	0.00	0.013	6.00	20.00	1
Dixon	DIX560L	DIX560N	DIX555N	BRIDGE	220.00	219.73	52	0.00	0.013	7.00	6.30	2
Dixon	DIX575L	DIX575N	DIX570N	BRIDGE	224.15	223.46	127	0.00	0.013	5.20	10.60	2
Dixon	DIX590L	DIX590N	DIX585N	BRIDGE	229.00	228.50	100	0.00	0.013	5.50	21.70	1
Dixon	DIX600L	DIX600N	DIX595N	BRIDGE	234.70	234.50	135	0.00	0.013	5.70	22.00	1
Dixon	DIX610L	DIX610N	DIX605N	BRIDGE	238.70	238.20	59	0.00	0.013	5.70	19.00	1
Dixon	DIX620L	DIX620N	DIX615N	BRIDGE	243.30	243.00	22	0.00	0.013	12.00	6.00	1
Dixon	DIX635L	DIX635N	DIX630N	BRIDGE	256.50	256.00	53	0.00	0.013	3.90	16.50	1
Dixon	DIX645L	DIX645N	DIX640N	BRIDGE	260.40	259.58	86	0.00	0.013	8.00	12.00	1
Dixon	DIX675L	DIX675N	DIX670N	BRIDGE	260.55	259.65	90	0.00	0.013	4.00	6.00	1
Dixon	DIX840L	DIX840N	DIX835N	BRIDGE	302.50	302.00	41	0.00	0.013	4.10	6.30	1
Dixon	DIX850L	DIX850N	DIX845N	BRIDGE	318.50	318.00	44	0.00	0.013	3.00	4.00	1
Dixon	DIX860L	DIX860N	DIX855N	BRIDGE	338.12	330.32	140	0.00	0.025	2.70	5.30	1
Dixon	DIX655L	DIX655N	DIX650N	CULVERT	265.56	264.27	72	5.00	0.013	0.00	0.00	1
Dixon	DIX685L	DIX685N	DIX680N	CULVERT	272.50	272.00	45	3.00	0.013	0.00	0.00	1
Dixon	DIX705L	DIX705N	DIX700N	CULVERT	280.60	279.40	85	5.00	0.013	0.00	0.00	1
Dixon	DIX730L	DIX730N	DIX725N	CULVERT	384.00	382.60	70	1.75	0.025	0.00	0.00	1
Dixon	DIX755L	DIX755N	DIX750N	CULVERT	386.00	383.60	59	2.50	0.025	0.00	0.00	1
Dixon	DIX780L	DIX780N	DIX775N	CULVERT	389.00	387.60	70	1.75	0.025	0.00	0.00	1
Dixon	DIX800L	DIX800N	DIX795N	CULVERT	392.50	386.70	160	1.50	0.013	0.00	0.00	1
Dixon	DIX830L	DIX830N	DIX825N	CULVERT	296.50	296.00	58	3.00	0.013	0.00	0.00	1
Dixon	DIX870L	DIX870N	DIX865N	CULVERT	372.00	371.50	80	3.00	0.013	0.00	0.00	1
Dixon	DIX880L	DIX880N	DIX875N	CULVERT	442.50	442.00	37	3.00	0.013	0.00	0.00	1
Dixon	DIX900L	DIX900N	DIX895N	CULVERT	433.00	432.00	21	2.00	0.013	0.00	0.00	1
Dixon	DIX910L	DIX910N	DIX905N	CULVERT	462.50	462.00	52	2.00	0.013	0.00	0.00	1
Dixon	DIX920L	DIX920N	DIX915N	CULVERT	437.50	437.00	30	2.00	0.013	0.00	0.00	1

Table A-3. Closed Conduit Parameters

Basin	Name	Upstream Node	Downstream Node	Conduit Type	US Invert Elev., ft	DS Invert Elev., ft	Length, ft	Circular Dia, ft	Mannings Roughness	Box Depth, ft	Box Width, ft	No. of conduits
Dixon	DIX940L	DIX940N	DIX935N	CULVERT	472.00	462.00	289	2.00	0.013	0.00	0.00	1
Dixon	DIX965L	DIX965N	DIX960N	CULVERT	534.50	534.00	37	2.00	0.013	0.00	0.00	1
Dixon	DIX975L	DIX975N	DIX970N	CULVERT	552.50	552.00	24	2.00	0.013	0.00	0.00	1
Dixon	DIX985L	DIX985N	DIX980N	CULVERT	558.50	558.00	21	2.00	0.013	0.00	0.00	1
Dixon	DIX995L	DIX995N	DIX990N	CULVERT	576.50	576.00	29	2.00	0.013	0.00	0.00	1
Dixon	DIX260L	DIX260N	DIX530N	PIPE	219.70	216.30	920	3.00	0.013	0.00	0.00	1
Dixon	DIX265L	DIX265N	DIX260N	PIPE	220.19	219.70	217	3.00	0.013	0.00	0.00	1
Dixon	DIX270L	DIX270N	DIX265N	PIPE	220.40	220.19	81	3.00	0.013	0.00	0.00	1
Dixon	DIX275L	DIX275N	DIX270N	PIPE	220.90	220.40	259	3.00	0.013	0.00	0.00	1
Dixon	DIX280L	DIX280N	DIX275N	PIPE	222.07	220.90	570	3.00	0.013	0.00	0.00	1
Dixon	DIX285L	DIX285N	DIX280N	PIPE	222.83	222.07	381	3.00	0.013	0.00	0.00	1
Dixon	DIX290L	DIX290N	DIX285N	PIPE	223.63	222.83	378	3.00	0.013	0.00	0.00	1
Dixon	DIX295L	DIX295N	DIX290N	PIPE	224.42	223.63	260	2.00	0.013	0.00	0.00	1
Dixon	DIX300L	DIX300N	DIX295N	PIPE	224.47	224.42	25	2.00	0.013	0.00	0.00	1
Dixon	DIX305L	DIX305N	DIX300N	PIPE	225.45	224.47	407	2.00	0.013	0.00	0.00	1
Dixon	DIX310L	DIX310N	DIX305N	PIPE	227.93	225.45	405	1.50	0.013	0.00	0.00	1
Dixon	DIX315L	DIX315N	DIX310N	PIPE	229.55	227.93	236	1.50	0.013	0.00	0.00	1
Dixon	DIX320L	DIX320N	DIX315N	PIPE	230.40	229.55	172	1.50	0.013	0.00	0.00	1
Dixon	DIX325L	DIX325N	DIX320N	PIPE	230.99	230.40	121	1.50	0.013	0.00	0.00	1
Dixon	DIX330L	DIX330N	DIX325N	PIPE	235.57	230.99	266	1.50	0.013	0.00	0.00	1
Dixon	DIX335L	DIX335N	DIX330N	PIPE	239.96	235.57	259	1.50	0.013	0.00	0.00	1
Dixon	DIX340L	DIX340N	DIX335N	PIPE	246.53	239.96	367	1.50	0.013	0.00	0.00	1
Dixon	DIX345L	DIX345N	DIX690N	PIPE	274.58	273.00	95	3.00	0.013	0.00	0.00	1
Dixon	DIX350L	DIX350N	DIX345N	PIPE	275.00	274.58	81	3.00	0.013	0.00	0.00	1
Dixon	DIX355L	DIX355N	DIX350N	PIPE	281.50	275.00	347	3.00	0.013	0.00	0.00	1
Dixon	DIX360L	DIX360N	DIX395N	PIPE	237.73	234.65	614	3.00	0.013	0.00	0.00	1
Dixon	DIX365L	DIX365N	DIX360N	PIPE	240.53	237.73	471	3.00	0.013	0.00	0.00	1
Dixon	DIX370L	DIX370N	DIX365N	PIPE	247.18	240.53	557	3.00	0.013	0.00	0.00	1
Dixon	DIX375L	DIX375N	DIX370N	PIPE	253.56	247.18	477	3.00	0.013	0.00	0.00	1
Dixon	DIX380L	DIX380N	DIX375N	PIPE	273.93	253.56	626	3.00	0.013	0.00	0.00	1
Dixon	DIX385L	DIX385N	DIX380N	PIPE	284.00	273.93	268	3.00	0.013	0.00	0.00	1
Dixon	DIX390L	DIX390N	DIX385N	PIPE	292.00	284.00	171	3.00	0.013	0.00	0.00	1
Dixon	DIX395L	DIX395N	DIX595N	PIPE	234.65	234.50	59	3.00	0.013	0.00	0.00	1
Dixon	DIX400L	DIX400N	DIX395N	PIPE	239.09	234.65	589	3.00	0.013	0.00	0.00	1
Dixon	DIX405L	DIX405N	DIX400N	PIPE	242.98	239.09	520	3.00	0.013	0.00	0.00	1
Dixon	DIX410L	DIX410N	DIX405N	PIPE	252.03	242.98	580	3.00	0.013	0.00	0.00	1
Dixon	DIX415L	DIX415N	DIX410N	PIPE	258.50	252.03	402	3.00	0.013	0.00	0.00	1

Table A-3. Closed Conduit Parameters

Basin	Name	Upstream Node	Downstream Node	Conduit Type	US Invert Elev., ft	DS Invert Elev., ft	Length, ft	Circular Dia, ft	Mannings Roughness	Box Depth, ft	Box Width, ft	No. of conduits
Dixon	DIX420L	DIX420N	DIX590N	PIPE	231.44	230.93	307	3.00	0.013	0.00	0.00	1
Dixon	DIX425L	DIX425N	DIX420N	PIPE	231.73	231.44	65	2.50	0.013	0.00	0.00	1
Dixon	DIX430L	DIX430N	DIX425N	PIPE	233.55	231.73	473	2.50	0.013	0.00	0.00	1
Dixon	DIX435L	DIX435N	DIX430N	PIPE	234.69	233.55	346	2.25	0.013	0.00	0.00	1
Dixon	DIX440L	DIX440N	DIX435N	PIPE	243.52	234.69	465	1.75	0.013	0.00	0.00	1
Dixon	DIX445L	DIX445N	DIX440N	PIPE	245.34	243.52	100	1.75	0.013	0.00	0.00	1
Dixon	DIX450L	DIX450N	DIX445N	PIPE	248.70	245.34	179	1.75	0.013	0.00	0.00	1
Dixon	DIX455L	DIX455N	DIX450N	PIPE	254.59	248.70	168	1.75	0.013	0.00	0.00	1
Dixon	DIX460L	DIX460N	DIX455N	PIPE	258.86	254.59	121	1.75	0.013	0.00	0.00	1
Dixon	DIX465L	DIX465N	DIX460N	PIPE	273.30	258.86	267	1.75	0.013	0.00	0.00	1
Squaw	SQW000L	SQW000N	SQWOUTN	BRIDGE	206.00	205.50	48	0.00	0.013	10.50	27.86	1
Squaw	SQW020L	SQW020N	SQW015N	BRIDGE	220.90	220.70	36	0.00	0.035	3.40	20.00	1
Squaw	SQW030L	SQW030N	SQW025N	BRIDGE	226.80	226.50	57	0.00	0.013	6.00	22.00	1
Squaw	SQW045L	SQW045N	SQW040N	BRIDGE	228.75	228.50	52.5	0.00	0.013	4.00	6.00	3
Squaw	SQW125L	SQW125N	SQW085N	BRIDGE	237.05	236.55	100	0.00	0.013	6.00	4.00	2
Squaw	SQW205L	SQW205N	SQW200N	BRIDGE	233.00	232.75	24	0.00	0.013	6.00	15.00	1
Squaw	SQW215L	SQW215N	SQW210N	BRIDGE	234.00	233.50	55	0.00	0.013	4.00	6.00	2
Squaw	SQW230L	SQW230N	SQW220N	BRIDGE	234.00	233.50	52	0.00	0.013	4.00	6.00	2
Squaw	SQW235L	SQW235N	SQW230N	BRIDGE	235.00	234.00	56	0.00	0.013	4.00	6.00	2
Squaw	SQW240L	SQW240N	SQW235N	BRIDGE	236.00	235.00	56	0.00	0.013	4.00	6.00	1
Squaw	SQW250L	SQW250N	SQW245N	BRIDGE	242.00	240.00	37.5	0.00	0.013	4.00	10.00	2
Squaw	SQW055L	SQW055N	SQW050N	CULVERT	233.39	233.10	67.5	4.50	0.013	0.00	0.00	3
Squaw	SQW135L	SQW135N	SQW130N	CULVERT	244.50	244.00	82	2.00	0.014	0.00	0.00	2
Squaw	SQW145L	SQW145N	SQW140N	CULVERT	252.00	251.50	77	5.39	0.014	0.00	0.00	1
Squaw	SQW260L	SQW260N	SQW255N	CULVERT	257.00	256.00	73	5.00	0.013	0.00	0.00	1
Squaw	SQW265L	SQW265N	SQW080N	CULVERT	255.00	254.00	76	4.00	0.014	0.00	0.00	1
Squaw	SQW090L	SQW090N	SQW085N	PIPE	237.93	237.00	147	2.25	0.013	0.00	0.00	1
Squaw	SQW095L	SQW095N	SQW090N	PIPE	238.58	237.93	180	2.00	0.013	0.00	0.00	1
Squaw	SQW100L	SQW100N	SQW095N	PIPE	239.41	238.58	192	2.00	0.013	0.00	0.00	1
Squaw	SQW105L	SQW105N	SQW100N	PIPE	240.38	239.41	251	2.00	0.013	0.00	0.00	1
Squaw	SQW110L	SQW110N	SQW105N	PIPE	242.18	240.38	245	1.50	0.013	0.00	0.00	1
Squaw	SQW120L	SQW120N	SQW110N	PIPE	244.14	242.18	284	1.25	0.013	0.00	0.00	1
Squaw	SQW170L	SQW170N	SQW040N	PIPE	229.07	228.50	152	2.50	0.013	0.00	0.00	1
Squaw	SQW175L	SQW175N	SQW170N	PIPE	230.17	229.07	309	2.50	0.013	0.00	0.00	1
Squaw	SQW180L	SQW180N	SQW175N	PIPE	231.88	230.17	223	2.00	0.013	0.00	0.00	1
Squaw	SQW185L	SQW185N	SQW180N	PIPE	233.80	231.88	318	2.00	0.013	0.00	0.00	1
Squaw	SQW190L	SQW190N	SQW185N	PIPE	236.96	233.80	282	1.75	0.013	0.00	0.00	1

Table A-3. Closed Conduit Parameters

Basin	Name	Upstream Node	Downstream Node	Conduit Type	US Invert Elev., ft	DS Invert Elev., ft	Length, ft	Circular Dia, ft	Mannings Roughness	Box Depth, ft	Box Width, ft	No. of conduits
Squaw	SQW195L	SQW195N	SQW190N	PIPE	241.10	236.96	296	1.50	0.013	0.00	0.00	1
North	NOR005L	NOR005N	NOR000N	BRIDGE	217.64	217.00	67	0.00	0.013	5.00	14.00	2
North	NOR025L	NOR025N	NOR020N	BRIDGE	294.05	293.53	35	0.00	0.025	5.67	20.00	1
North	NOR060L	NOR060N	NOR055N	BRIDGE	261.52	261.00	49	0.00	0.025	6.24	9.00	1
North	NOR015L	NOR015N	NOR010N	CULVERT	263.24	262.58	95	9.25	0.025	0.00	0.00	1
North	NOR070L	NOR070N	NOR065N	CULVERT	311.67	310.81	43	6.00	0.025	0.00	0.00	1
Village Green	VLG015L	VLG015N	VLG010N	BRIDGE	206.10	206.00	50	0.00	0.035	5.67	16.00	1
Village Green	VLG025L	VLG025N	VLG020N	BRIDGE	207.60	207.34	84	0.00	0.013	4.40	4.20	2
Village Green	VLG005L	VLG005N	VLG000N	CULVERT	204.10	204.00	61	4.00	0.013	0.00	0.00	2
Village Green	VLG035L	VLG035N	VLG030N	CULVERT	209.00	208.70	54	3.50	0.013	0.00	0.00	3
Sequoia	SEQ005L	SEQ005N	SEQ000N	BRIDGE	201.10	201.00	28	0.00	0.013	4.00	10.00	1
Sequoia	SEQ025L	SEQ025N	SEQ020N	BRIDGE	212.49	212.30	12	0.00	0.035	5.67	16.00	1
Sequoia	SEQ120L	SEQ120N	SEQ115N	BRIDGE	217.38	216.62	96	0.00	0.013	4.00	6.00	2
Sequoia	SEQ160L	SEQ160N	SEQ155N	BRIDGE	218.20	218.00	85	0.00	0.013	4.00	5.00	2
Sequoia	SEQ170L	SEQ170N	SEQ165N	BRIDGE	218.50	218.40	222	0.00	0.013	5.00	10.00	1
Sequoia	SEQ175L	SEQ175N	SEQ170N	BRIDGE	220.00	218.70	364	0.00	0.013	5.00	10.00	1
Sequoia	SEQ180L	SEQ180N	SEQ175N	BRIDGE	221.04	220.20	360	0.00	0.013	5.00	10.00	1
Sequoia	SEQ185L	SEQ185N	SEQ180N	BRIDGE	223.02	221.60	275	0.00	0.025	5.00	10.00	1
Sequoia	SEQ130L	SEQ130N	SEQ125N	CULVERT	222.20	222.00	165	1.75	0.013	0.00	0.00	1
Sequoia	SEQ145L	SEQ145N	SEQ140N	CULVERT	226.00	225.90	113	1.50	0.013	0.00	0.00	1
Sequoia	SEQ315L	SEQ315N	SEQ310N	CULVERT	244.00	243.80	77	3.00	0.013	0.00	0.00	2
Sequoia	SEQ325L	SEQ325N	SEQ320N	CULVERT	250.50	250.30	59	3.50	0.025	0.00	0.00	1
Sequoia	SEQ335L	SEQ335N	SEQ330N	CULVERT	258.00	257.80	69	3.00	0.025	0.00	0.00	1
Sequoia	SEQ345L	SEQ345N	SEQ340N	CULVERT	294.25	292.18	91	4.50	0.025	0.00	0.00	1
Sequoia	SEQ035L	SEQ035N	SEQ030N	PIPE	213.60	213.56	14	4.00	0.013	0.00	0.00	1
Sequoia	SEQ040L	SEQ040N	SEQ035N	PIPE	213.78	213.60	68	4.00	0.013	0.00	0.00	1
Sequoia	SEQ045L	SEQ045N	SEQ040N	PIPE	213.85	213.78	46	4.00	0.013	0.00	0.00	1
Sequoia	SEQ050L	SEQ050N	SEQ045N	PIPE	213.95	213.85	53	4.00	0.013	0.00	0.00	1
Sequoia	SEQ055L	SEQ055N	SEQ050N	PIPE	214.57	213.95	336	3.00	0.013	0.00	0.00	1
Sequoia	SEQ060L	SEQ060N	SEQ055N	PIPE	215.13	214.57	326	3.00	0.013	0.00	0.00	1
Sequoia	SEQ065L	SEQ065N	SEQ060N	PIPE	215.18	215.13	21	3.00	0.013	0.00	0.00	1
Sequoia	SEQ070L	SEQ070N	SEQ065N	PIPE	215.74	215.18	302	3.00	0.013	0.00	0.00	1
Sequoia	SEQ075L	SEQ075N	SEQ070N	PIPE	215.91	215.74	53	3.00	0.013	0.00	0.00	1
Sequoia	SEQ080L	SEQ080N	SEQ075N	PIPE	216.67	215.91	303	3.00	0.013	0.00	0.00	1
Sequoia	SEQ092L	SEQ092N	SEQ190N	PIPE	220.53	220.10	22	2.50	0.013	0.00	0.00	1
Sequoia	SEQ195L	SEQ195N	SEQ190N	PIPE	220.10	220.10	19	3.00	0.013	0.00	0.00	1
Sequoia	SEQ200L	SEQ200N	SEQ195N	PIPE	220.36	220.10	342	3.00	0.013	0.00	0.00	1

Table A-3. Closed Conduit Parameters

Basin	Name	Upstream Node	Downstream Node	Conduit Type	US Invert Elev., ft	DS Invert Elev., ft	Length, ft	Circular Dia, ft	Mannings Roughness	Box Depth, ft	Box Width, ft	No. of conduits
Sequoia	SEQ205L	SEQ205N	SEQ190N	PIPE	220.97	220.10	630	3.00	0.013	0.00	0.00	1
Sequoia	SEQ210L	SEQ210N	SEQ092N	PIPE	222.78	220.53	431	2.50	0.013	0.00	0.00	1
Sequoia	SEQ220L	SEQ220N	SEQ210N	PIPE	225.00	222.78	423	2.50	0.013	0.00	0.00	1
Sequoia	SEQ225L	SEQ225N	SEQ220N	PIPE	227.90	225.23	268	2.00	0.013	0.00	0.00	1
Sequoia	SEQ230L	SEQ230N	SEQ225N	PIPE	227.00	228.00	53	2.00	0.013	0.00	0.00	1
Sequoia	SEQ231L	SEQ230N	SEQ305N	PIPE	227.00	227.00	44	4.50	0.013	0.00	0.00	1
Sequoia	SEQ235L	SEQ235N	SEQ230N	PIPE	230.12	227.00	606	4.00	0.013	0.00	0.00	1
Sequoia	SEQ240L	SEQ240N	SEQ235N	PIPE	233.40	230.12	500	4.00	0.013	0.00	0.00	1
Sequoia	SEQ245L	SEQ245N	SEQ240N	PIPE	234.50	234.40	50	3.00	0.013	0.00	0.00	1
Sequoia	SEQ250L	SEQ250N	SEQ245N	PIPE	235.00	234.50	62	3.00	0.013	0.00	0.00	1
Sequoia	SEQ255L	SEQ255N	SEQ250N	PIPE	236.65	235.00	103	2.50	0.013	0.00	0.00	1
Sequoia	SEQ260L	SEQ260N	SEQ255N	PIPE	241.20	236.65	285	2.50	0.013	0.00	0.00	1
Sequoia	SEQ265L	SEQ265N	SEQ305N	PIPE	237.00	227.00	407	2.00	0.013	0.00	0.00	1
Sequoia	SEQ270L	SEQ270N	SEQ265N	PIPE	249.53	241.08	107	1.50	0.013	0.00	0.00	1
Sequoia	SEQ275L	SEQ275N	SEQ270N	PIPE	266.81	249.53	247	1.50	0.013	0.00	0.00	1
Sequoia	SEQ280L	SEQ280N	SEQ275N	PIPE	271.93	266.81	73	1.50	0.013	0.00	0.00	1
Sequoia	SEQ285L	SEQ285N	SEQ280N	PIPE	287.95	272.03	383	1.50	0.013	0.00	0.00	1
Sequoia	SEQ305L	SEQ305N	SEQ370N	PIPE	225.69	225.44	124	4.50	0.013	0.00	0.00	1
Sequoia	SEQ360L	SEQ360N	SEQ185N	PIPE	223.79	223.02	133	4.50	0.013	0.00	0.00	1
Sequoia	SEQ365L	SEQ365N	SEQ360N	PIPE	224.79	223.79	545	4.50	0.013	0.00	0.00	1
Sequoia	SEQ370L	SEQ370N	SEQ365N	PIPE	225.44	224.79	539	4.50	0.013	0.00	0.00	1
Sequoia	SEQ375L	SEQ375N	SEQ245N	PIPE	236.74	234.50	66	2.50	0.013	0.00	0.00	1
Sequoia	SEQ380L	SEQ380N	SEQ375N	PIPE	247.00	236.74	347	2.50	0.013	0.00	0.00	1
Sequoia	SEQ385L	SEQ385N	SEQ380N	PIPE	252.75	247.00	191	2.50	0.013	0.00	0.00	1
Sequoia	SEQ390L	SEQ390N	SEQ385N	PIPE	266.50	252.75	280	2.50	0.013	0.00	0.00	1
Garfield	GAR005L	GAR005N	GAR000N	CULVERT	202.75	200.23	84	3.00	0.025	0.00	0.00	1
Garfield	GAR020L	GAR020N	GAR015N	CULVERT	214.49	214.44	48	4.00	0.025	0.00	0.00	1
Garfield	GAR030L	GAR030N	GAR025N	CULVERT	214.92	214.86	52.5	4.00	0.025	0.00	0.00	1
Garfield	GAR045L	GAR045N	GAR040N	PIPE	217.00	216.63	101	3.00	0.013	0.00	0.00	1
Garfield	GAR050L	GAR050N	GAR045N	PIPE	218.10	217.20	311	3.00	0.013	0.00	0.00	1
Garfield	GAR055L	GAR055N	GAR050N	PIPE	218.48	218.10	39	3.00	0.013	0.00	0.00	1
Garfield	GAR060L	GAR060N	GAR055N	PIPE	220.81	218.48	40	2.00	0.013	0.00	0.00	1
Garfield	GAR065L	GAR065N	GAR060N	PIPE	221.32	220.81	514	2.00	0.013	0.00	0.00	1
Garfield	GAR070L	GAR070N	GAR065N	PIPE	221.73	221.32	388	2.00	0.013	0.00	0.00	1
Garfield	GAR075L	GAR075N	GAR070N	PIPE	221.98	221.73	218	2.00	0.013	0.00	0.00	1
Garfield	GAR080L	GAR080N	GAR055N	PIPE	218.83	218.48	48	2.00	0.013	0.00	0.00	1
Garfield	GAR085L	GAR085N	GAR080N	PIPE	219.24	218.83	364	1.50	0.013	0.00	0.00	1

Table A-3. Closed Conduit Parameters

Basin	Name	Upstream Node	Downstream Node	Conduit Type	US Invert Elev., ft	DS Invert Elev., ft	Length, ft	Circular Dia, ft	Mannings Roughness	Box Depth, ft	Box Width, ft	No. of conduits
Garfield	GAR090L	GAR090N	GAR085N	PIPE	219.51	219.24	292	1.50	0.013	0.00	0.00	1
Garfield	GAR095L	GAR095N	GAR090N	PIPE	219.63	219.51	123	1.50	0.013	0.00	0.00	1
Garfield	GAR100L	GAR100N	GAR035N	PIPE	215.88	215.70	100	3.50	0.013	0.00	0.00	1
Garfield	GAR105L	GAR105N	GAR100N	PIPE	216.63	215.88	461	3.50	0.013	0.00	0.00	1
Garfield	GAR110L	GAR110N	GAR105N	PIPE	217.02	216.63	224	3.50	0.013	0.00	0.00	1
Garfield	GAR120L	GAR120N	GAR110N	PIPE	217.81	217.02	578	3.50	0.013	0.00	0.00	1
Garfield	GAR125L	GAR125N	GAR120N	PIPE	218.37	217.81	265	3.50	0.013	0.00	0.00	1
Garfield	GAR130L	GAR130N	GAR125N	PIPE	218.56	218.37	98	3.00	0.013	0.00	0.00	1
Garfield	GAR135L	GAR135N	GAR130N	PIPE	218.38	218.56	182	2.25	0.013	0.00	0.00	1
Garfield	GAR140L	GAR140N	GAR135N	PIPE	218.80	218.38	170	2.25	0.013	0.00	0.00	1
Garfield	GAR145L	GAR145N	GAR140N	PIPE	219.22	218.80	364	2.25	0.013	0.00	0.00	1
Garfield	GAR150L	GAR150N	GAR145N	PIPE	219.72	219.22	22	2.25	0.013	0.00	0.00	1
Oak	OAK010L	OAK010N	OAK005N	BRIDGE	202.48	201.50	122	0.00	0.025	12.00	12.00	2
Oak	OAK020L	OAK020N	OAK015N	BRIDGE	203.00	202.75	31	0.00	0.025	17.00	26.00	2
Oak	OAK030L	OAK030N	OAK025N	BRIDGE	210.00	209.50	50	0.00	0.025	10.00	34.00	1
Oak	OAK040L	OAK040N	OAK035N	BRIDGE	217.00	216.00	45	0.00	0.025	6.50	35.30	1
Oak	OAK065L	OAK065N	OAK060N	BRIDGE	221.00	220.00	90	0.00	0.025	10.00	43.00	1
Oak	OAK085L	OAK085N	OAK080N	BRIDGE	225.00	224.50	21	0.00	0.025	11.00	25.50	1
Oak	OAK135L	OAK135N	OAK130N	BRIDGE	266.00	265.50	64	0.00	0.025	6.00	31.50	1
Oak	OAK145L	OAK145N	OAK140N	BRIDGE	279.00	278.50	81	0.00	0.025	9.00	15.60	1
Oak	OAK160L	OAK160N	OAK155N	BRIDGE	299.96	299.50	73	0.00	0.025	9.00	20.00	1
Oak	OAK115L	OAK115N	OAK110N	CULVERT	262.30	261.80	67	7.00	0.025	0.00	0.00	2
Oak	OAK230L	OAK230N	OAK225N	CULVERT	268.85	268.00	129	5.50	0.025	0.00	0.00	1
Oak	OAK240L	OAK240N	OAK235N	CULVERT	284.00	280.00	157	3.00	0.025	0.00	0.00	1
Oak	OAK250L	OAK250N	OAK245N	CULVERT	301.00	296.00	164	7.50	0.025	0.00	0.00	1
Oak	OAK260L	OAK260N	OAK255N	CULVERT	269.05	268.55	167	5.75	0.025	0.00	0.00	1
Oak	OAK285L	OAK285N	OAK280N	CULVERT	335.36	334.88	211	7.50	0.025	0.00	0.00	1
Oak	OAK295L	OAK295N	OAK033N	PIPE	213.13	211.00	274	4.00	0.013	0.00	0.00	1
Oak	OAK305L	OAK305N	OAK295N	PIPE	216.59	213.13	309	3.00	0.013	0.00	0.00	1
Oak	OAK310L	OAK310N	OAK305N	PIPE	219.87	216.59	293	3.00	0.013	0.00	0.00	1
Oak	OAK315L	OAK315N	OAK310N	PIPE	223.43	219.87	318	3.00	0.013	0.00	0.00	1
Oak	OAK325L	OAK325N	OAK315N	PIPE	224.25	223.43	73	3.00	0.013	0.00	0.00	1
Oak	OAK330L	OAK330N	OAK325N	PIPE	225.32	224.25	260	3.00	0.013	0.00	0.00	1
Oak	OAK335L	OAK335N	OAK330N	PIPE	226.16	225.32	202	3.00	0.013	0.00	0.00	1
Oak	OAK340L	OAK340N	OAK335N	PIPE	226.54	226.16	91	3.00	0.013	0.00	0.00	1
Oak	OAK345L	OAK345N	OAK340N	PIPE	228.00	226.54	353	3.00	0.013	0.00	0.00	1
Oak	OAK355L	OAK355N	OAK350N	PIPE	234.96	234.15	304	1.50	0.013	0.00	0.00	1

Table A-3. Closed Conduit Parameters

Basin	Name	Upstream Node	Downstream Node	Conduit Type	US Invert Elev., ft	DS Invert Elev., ft	Length, ft	Circular Dia, ft	Mannings Roughness	Box Depth, ft	Box Width, ft	No. of conduits
Oak	OAK365L	OAK365N	OAK355N	PIPE	235.71	234.96	279	1.50	0.013	0.00	0.00	1
Oak	OAK370L	OAK370N	OAK365N	PIPE	238.35	235.71	984	1.50	0.013	0.00	0.00	1
Oak	OAK375L	OAK375N	OAK370N	PIPE	236.53	238.35	55	1.50	0.013	0.00	0.00	1
Oak	OAK376L	OAK375N	OAK420N	PIPE	239.90	235.07	355	1.50	0.013	0.00	0.00	1
Oak	OAK380L	OAK380N	OAK345N	PIPE	228.24	228.00	70	3.00	0.013	0.00	0.00	1
Oak	OAK385L	OAK385N	OAK380N	PIPE	229.19	228.24	284	3.00	0.013	0.00	0.00	1
Oak	OAK390L	OAK390N	OAK385N	PIPE	230.03	229.19	251	3.00	0.013	0.00	0.00	1
Oak	OAK395L	OAK395N	OAK390N	PIPE	230.90	230.03	261	3.00	0.013	0.00	0.00	1
Oak	OAK400L	OAK400N	OAK395N	PIPE	231.53	230.90	207	1.50	0.013	0.00	0.00	1
Oak	OAK405L	OAK405N	OAK400N	PIPE	232.08	231.53	186	1.50	0.013	0.00	0.00	1
Oak	OAK410L	OAK410N	OAK405N	PIPE	232.66	232.08	196	1.50	0.013	0.00	0.00	1
Oak	OAK415L	OAK415N	OAK410N	PIPE	233.63	232.66	327	1.50	0.013	0.00	0.00	1
Oak	OAK420L	OAK420N	OAK415N	PIPE	235.07	233.63	105	1.50	0.013	0.00	0.00	1
Marys River	MRY001L	MRY001N	MRY000N	CULVERT	20.00	18.92	53	2.00	0.013	0.00	0.00	1
Marys River	MRY003L	MRY003N	MRY002N	CULVERT	20.00	19.17	57	2.00	0.013	0.00	0.00	1
Marys River	MRY005L	MRY005N	MRY004N	CULVERT	20.00	5.58	84.5	2.00	0.013	0.00	0.00	1
Goodnight	GDN190L	GDN190N	GDN185N	CULVERT	233.50	233.50	75	1.00	0.013	0.00	0.00	4
Goodnight	GDN560L	GDN560N	GDN555N	CULVERT	232.00	232.00	97	1.50	0.013	0.00	0.00	1
Goodnight	GDN570L	GDN570N	GDN565N	CULVERT	232.70	232.60	103	1.00	0.013	0.00	0.00	1
Goodnight	GDN005L	GDN005N	GDN000N	PIPE	217.73	216.68	533	4.00	0.013	0.00	0.00	1
Goodnight	GDN010L	GDN010N	GDN005N	PIPE	218.43	217.73	448	4.00	0.013	0.00	0.00	1
Goodnight	GDN015L	GDN015N	GDN010N	PIPE	219.23	218.43	401	4.00	0.013	0.00	0.00	1
Goodnight	GDN030L	GDN030N	GDN015N	PIPE	221.33	219.23	505	3.50	0.013	0.00	0.00	1
Goodnight	GDN035L	GDN035N	GDN030N	PIPE	222.22	221.33	370	3.50	0.013	0.00	0.00	1
Goodnight	GDN040L	GDN040N	GDN035N	PIPE	222.53	222.22	131	3.50	0.013	0.00	0.00	1
Goodnight	GDN045L	GDN045N	GDN040N	PIPE	223.05	222.53	314	2.00	0.013	0.00	0.00	1
Goodnight	GDN050L	GDN050N	GDN045N	PIPE	224.33	223.05	112	2.00	0.013	0.00	0.00	1
Goodnight	GDN055L	GDN055N	GDN050N	PIPE	225.57	224.33	422	2.00	0.013	0.00	0.00	1
Goodnight	GDN060L	GDN060N	GDN040N	PIPE	223.42	222.53	236	3.00	0.013	0.00	0.00	1
Goodnight	GDN065L	GDN065N	GDN060N	PIPE	223.58	223.42	25	3.00	0.013	0.00	0.00	1
Goodnight	GDN075L	GDN075N	GDN065N	PIPE	224.60	223.58	508	3.00	0.013	0.00	0.00	1
Goodnight	GDN085L	GDN085N	GDN045N	PIPE	225.40	223.05	324	2.50	0.013	0.00	0.00	1
Goodnight	GDN090L	GDN090N	GDN085N	PIPE	226.40	225.40	234	2.50	0.013	0.00	0.00	1
Goodnight	GDN095L	GDN095N	GDN090N	PIPE	226.42	226.40	84	2.50	0.013	0.00	0.00	1
Goodnight	GDN100L	GDN100N	GDN095N	PIPE	226.76	226.42	136	3.00	0.013	0.00	0.00	1
Goodnight	GDN105L	GDN105N	GDN100N	PIPE	227.00	226.76	147	3.00	0.013	0.00	0.00	1
Goodnight	GDN110L	GDN110N	GDN105N	PIPE	227.20	227.00	134	3.00	0.013	0.00	0.00	1

Table A-3. Closed Conduit Parameters

Basin	Name	Upstream Node	Downstream Node	Conduit Type	US Invert Elev., ft	DS Invert Elev., ft	Length, ft	Circular Dia, ft	Mannings Roughness	Box Depth, ft	Box Width, ft	No. of conduits
Goodnight	GDN115L	GDN115N	GDN110N	PIPE	227.29	227.20	350	2.50	0.013	0.00	0.00	1
Goodnight	GDN120L	GDN120N	GDN115N	PIPE	227.51	227.29	216	2.50	0.013	0.00	0.00	1
Goodnight	GDN125L	GDN125N	GDN120N	PIPE	227.65	227.51	105	2.00	0.013	0.00	0.00	1
Goodnight	GDN130L	GDN130N	GDN125N	PIPE	227.94	227.65	166	2.00	0.013	0.00	0.00	1
Goodnight	GDN135L	GDN135N	GDN130N	PIPE	228.16	227.94	127	2.00	0.013	0.00	0.00	1
Goodnight	GDN140L	GDN140N	GDN135N	PIPE	228.53	228.16	104	1.50	0.013	0.00	0.00	1
Goodnight	GDN145L	GDN145N	GDN140N	PIPE	228.95	228.53	216	1.00	0.013	0.00	0.00	1
Goodnight	GDN150L	GDN150N	GDN145N	PIPE	229.87	228.95	341	1.00	0.013	0.00	0.00	1
Goodnight	GDN155L	GDN155N	GDN120N	PIPE	227.90	227.51	174	1.00	0.013	0.00	0.00	1
Goodnight	GDN160L	GDN160N	GDN155N	PIPE	228.50	227.90	196	1.00	0.013	0.00	0.00	1
Goodnight	GDN165L	GDN165N	GDN160N	PIPE	229.27	228.50	255	1.00	0.013	0.00	0.00	1
Goodnight	GDN185a	GDN185N	GDN525N	PIPE	234.30	228.00	147	0.83	0.013	0.00	0.00	1
Goodnight	GDN500L	GDN500N	GDN035N	PIPE	223.75	223.40	132	2.00	0.013	0.00	0.00	1
Goodnight	GDN510L	GDN510N	GDN500N	PIPE	224.15	223.75	84	2.00	0.013	0.00	0.00	1
Goodnight	GDN515L	GDN515N	GDN510N	PIPE	224.73	224.15	133	2.00	0.013	0.00	0.00	1
Goodnight	GDN520L	GDN520N	GDN515N	PIPE	225.47	224.73	139	2.00	0.013	0.00	0.00	1
Goodnight	GDN525L	GDN525N	GDN520N	PIPE	225.93	225.47	145	2.00	0.013	0.00	0.00	1
Goodnight	GDN530L	GDN530N	GDN525N	PIPE	226.26	226.13	64	2.00	0.013	0.00	0.00	1
Goodnight	GDN535L	GDN535N	GDN530N	PIPE	227.00	226.47	132	1.50	0.013	0.00	0.00	1
Goodnight	GDN540L	GDN540N	GDN535N	PIPE	227.74	227.22	117	1.50	0.013	0.00	0.00	1
Goodnight	GDN545L	GDN545N	GDN540N	PIPE	228.60	228.00	265	1.25	0.013	0.00	0.00	1
Goodnight	GDN550L	GDN550N	GDN545N	PIPE	229.04	228.70	69	1.25	0.013	0.00	0.00	1
Mill Race	MIL030L	MIL030N	MIL025N	BRIDGE	199.00	198.50	54	0.00	0.025	15.00	22.00	1
Mill Race	MIL045L	MIL045N	MIL040N	BRIDGE	208.26	208.00	35	0.00	0.025	8.50	19.60	1
Mill Race	MIL060L	MIL060N	MIL055N	BRIDGE	208.70	208.63	111	0.00	0.025	8.00	20.00	1
Mill Race	MIL010L	MIL010N	MIL005N	CULVERT	203.25	202.75	412	11.25	0.025	0.00	0.00	1
Mill Race	MIL020L	MIL020N	MIL015N	CULVERT	204.00	203.30	73	0.00	0.025	11.50	0.00	1
Mill Race	MIL080L	MIL080N	MIL075N	CULVERT	208.11	208.00	45	4.00	0.025	0.00	0.00	1

TABLE A-4

OPEN CHANNEL PARAMETERS

Table A-4. Open Channel Parameters

Basin	Name	Upstream Node	Downstream Node	Conduit Type	US Invert Elev., ft	DS Invert Elev., ft	Length, ft	Left Bank Roughness	Channel Roughness	Right Bank Roughness	Left Bank Slope	Right Bank Slope	Channel Roughness	Depth, ft	Width, ft
Dixon	DIX220L	DIX220N	DIX485N	NCHANNEL	207.00	206.40	228	0.035	0.020	0.035	0.00	0.00	0.000	0.00	0.00
Dixon	DIX230L	DIX230N	DIX475N	NCHANNEL	203.00	198.00	1086	0.035	0.020	0.035	0.00	0.00	0.000	0.00	0.00
Dixon	DIX240L	DIX240N	DIX235N	NCHANNEL	204.00	203.50	203	0.035	0.020	0.035	0.00	0.00	0.000	0.00	0.00
Dixon	DIX250L	DIX250N	DIX245N	NCHANNEL	204.50	204.30	39	0.035	0.020	0.035	0.00	0.00	0.000	0.00	0.00
Dixon	DIX480L	DIX480N	DIX255N	NCHANNEL	206.00	205.00	240	0.035	0.020	0.035	0.00	0.00	0.000	0.00	0.00
Dixon	DIX490L	DIX490N	DIX225N	NCHANNEL	211.00	207.50	560	0.035	0.020	0.035	0.00	0.00	0.000	0.00	0.00
Dixon	DIX500L	DIX500N	DIX495N	NCHANNEL	213.00	211.60	279	0.035	0.020	0.035	0.00	0.00	0.000	0.00	0.00
Dixon	DIX510L	DIX510N	DIX505N	NCHANNEL	213.80	213.30	671	0.035	0.020	0.035	0.00	0.00	0.000	0.00	0.00
Dixon	DIX520L	DIX520N	DIX515N	NCHANNEL	214.30	214.00	250	0.035	0.020	0.035	0.00	0.00	0.000	0.00	0.00
Dixon	DIX530L	DIX530N	DIX525N	NCHANNEL	216.00	214.50	667	0.035	0.020	0.035	0.00	0.00	0.000	0.00	0.00
Dixon	DIX540L	DIX540N	DIX535N	NCHANNEL	218.30	216.30	915	0.035	0.020	0.035	0.00	0.00	0.000	0.00	0.00
Dixon	DIX555L	DIX555N	DIX545N	NCHANNEL	219.73	218.80	476	0.035	0.020	0.035	0.00	0.00	0.000	0.00	0.00
Dixon	DIX565L	DIX565N	DIX560N	NCHANNEL	222.00	220.00	843	0.035	0.020	0.035	0.00	0.00	0.000	0.00	0.00
Dixon	DIX570L	DIX570N	DIX565N	NCHANNEL	223.46	222.00	715	0.035	0.020	0.035	0.00	0.00	0.000	0.00	0.00
Dixon	DIX580L	DIX580N	DIX575N	NCHANNEL	228.00	224.15	1084	0.035	0.020	0.035	0.00	0.00	0.000	0.00	0.00
Dixon	DIX585L	DIX585N	DIX580N	NCHANNEL	228.50	228.00	513	0.035	0.020	0.035	0.00	0.00	0.000	0.00	0.00
Dixon	DIX595L	DIX595N	DIX590N	NCHANNEL	234.50	229.00	867	0.035	0.020	0.035	0.00	0.00	0.000	0.00	0.00
Dixon	DIX605L	DIX605N	DIX600N	NCHANNEL	238.20	234.70	556	0.035	0.020	0.035	0.00	0.00	0.000	0.00	0.00
Dixon	DIX615L	DIX615N	DIX613N	NCHANNEL	243.00	239.00	322	0.035	0.020	0.035	0.00	0.00	0.000	0.00	0.00
Dixon	DIX630L	DIX630N	DIX625N	NCHANNEL	256.00	247.00	588	0.035	0.020	0.035	0.00	0.00	0.000	0.00	0.00
Dixon	DIX660L	DIX660N	DIX655N	NCHANNEL	287.00	265.56	1133	0.035	0.020	0.035	0.00	0.00	0.000	0.00	0.00
Dixon	DIX665L	DIX665N	DIX635N	NCHANNEL	257.50	256.50	104	0.035	0.020	0.035	0.00	0.00	0.000	0.00	0.00
Dixon	DIX695L	DIX695N	DIX675N	NCHANNEL	263.00	260.55	455	0.035	0.020	0.035	0.00	0.00	0.000	0.00	0.00
Dixon	DIX785L	DIX785N	DIX705N	NCHANNEL	295.00	280.60	379	0.035	0.020	0.035	0.00	0.00	0.000	0.00	0.00
Dixon	DIX845L	DIX845N	DIX840N	NCHANNEL	318.00	302.50	646	0.035	0.020	0.035	0.00	0.00	0.000	0.00	0.00
Dixon	DIX855L	DIX855N	DIX850N	NCHANNEL	330.32	318.50	625	0.035	0.020	0.035	0.00	0.00	0.000	0.00	0.00
Dixon	DIX865L	DIX865N	DIX860N	NCHANNEL	371.50	338.12	740	0.035	0.020	0.035	0.00	0.00	0.000	0.00	0.00
Dixon	DIX915L	DIX915N	DIX890N	NCHANNEL	437.00	422.00	412	0.035	0.020	0.035	0.00	0.00	0.000	0.00	0.00
Dixon	DIX613L	DIX613N	DIX610N	TCHANNEL	239.00	238.70	568	0.000	0.000	0.000	0.50	0.50	0.035	7.00	7.00
Dixon	DIX625L	DIX625N	DIX620N	TCHANNEL	247.00	243.30	741	0.000	0.000	0.000	0.50	0.50	0.035	7.00	7.00
Dixon	DIX640L	DIX640N	DIX665N	TCHANNEL	259.58	257.50	150	0.000	0.000	0.000	0.50	0.50	0.035	5.00	5.00
Dixon	DIX650L	DIX650N	DIX645N	TCHANNEL	264.27	260.40	624	0.000	0.000	0.000	1.00	1.00	0.035	4.00	4.00
Dixon	DIX670L	DIX670N	DIX805N	TCHANNEL	259.65	259.00	133	0.000	0.000	0.000	0.50	0.50	0.035	5.00	5.00
Dixon	DIX680L	DIX680N	DIX695N	TCHANNEL	272.00	263.00	331	0.000	0.000	0.000	1.00	1.00	0.035	4.00	4.00
Dixon	DIX690L	DIX690N	DIX685N	TCHANNEL	273.00	272.50	183	0.000	0.000	0.000	1.00	1.00	0.035	4.00	4.00
Dixon	DIX698L	DIX698N	DIX695N	TCHANNEL	263.50	263.00	588	0.000	0.000	0.000	1.00	1.00	0.035	4.00	4.00
Dixon	DIX700L	DIX700N	DIX698N	TCHANNEL	279.40	263.50	661	0.000	0.000	0.000	1.00	1.00	0.035	4.00	4.00
Dixon	DIX710L	DIX710N	DIX785N	TCHANNEL	320.00	295.00	650	0.000	0.000	0.000	1.00	1.00	0.035	4.00	4.00

Table A-4. Open Channel Parameters

Basin	Name	Upstream Node	Downstream Node	Conduit Type	US Invert Elev., ft	DS Invert Elev., ft	Length, ft	Left Bank Roughness	Channel Roughness	Right Bank Roughness	Left Bank Slope	Right Bank Slope	Channel Roughness	Depth, ft	Width, ft
Squaw	SQW008L	SQW008N	SQW007N	NCHANNEL	214.56	212.88	481	0.200	0.150	0.200	0.00	0.00	0.000	0.00	0.00
Squaw	SQW010L	SQW010N	SQW008N	NCHANNEL	216.76	214.56	397	0.200	0.150	0.200	0.00	0.00	0.000	0.00	0.00
Squaw	SQW015L	SQW015N	SQW010N	NCHANNEL	220.70	216.76	685	0.200	0.150	0.200	0.00	0.00	0.000	0.00	0.00
Squaw	SQW021L	SQW021N	SQW020N	NCHANNEL	221.05	220.90	59	0.100	0.070	0.100	0.00	0.00	0.000	0.00	0.00
Squaw	SQW022L	SQW022N	SQW021N	NCHANNEL	221.79	221.05	276	0.100	0.070	0.100	0.00	0.00	0.000	0.00	0.00
Squaw	SQW023L	SQW023N	SQW022N	NCHANNEL	222.24	221.79	167	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
Squaw	SQW024L	SQW024N	SQW023N	NCHANNEL	222.84	222.24	233	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
Squaw	SQW025L	SQW025N	SQW024N	NCHANNEL	226.50	222.84	226	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
Squaw	SQW035L	SQW035N	SQW030N	NCHANNEL	228.00	226.80	788	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
Squaw	SQW040L	SQW040N	SQW035N	NCHANNEL	228.50	228.00	690	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
Squaw	SQW060L	SQW060N	SQW055N	NCHANNEL	235.00	233.39	900	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
Squaw	SQW075L	SQW075N	SQW060N	NCHANNEL	250.00	235.00	1715	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
Squaw	SQW150L	SQW150N	SQW145N	NCHANNEL	260.00	252.00	2479	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
Squaw	SQW165L	SQW165N	SQW160N	NCHANNEL	304.00	284.00	770	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
Squaw	SQW200L	SQW200N	SQW035N	NCHANNEL	232.75	228.00	1912	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
Squaw	SQW255L	SQW255N	SQW270N	NCHANNEL	256.00	250.00	2093	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
Squaw	SQW270L	SQW270N	SQW250N	NCHANNEL	250.00	242.00	1571	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
Squaw	SQW050L	SQW050N	SQW045N	TCHANNEL	233.10	228.75	1754	0.000	0.000	0.000	1.00	1.00	0.035	5.79	5.00
Squaw	SQW080L	SQW080N	SQW075N	TCHANNEL	254.00	250.00	1202	0.000	0.000	0.000	1.00	1.00	0.035	5.00	5.00
Squaw	SQW085L	SQW085N	SQW060N	TCHANNEL	236.55	235.00	851	0.000	0.000	0.000	1.00	1.00	0.035	5.00	5.00
Squaw	SQW130L	SQW130N	SQW125N	TCHANNEL	244.00	237.05	1096	0.000	0.000	0.000	1.00	1.00	0.035	5.00	5.00
Squaw	SQW140L	SQW140N	SQW135N	TCHANNEL	251.50	244.00	224	0.000	0.000	0.000	1.00	1.00	0.035	5.00	5.00
Squaw	SQW155L	SQW155N	SQW150N	TCHANNEL	276.00	260.00	2047	0.000	0.000	0.000	1.00	1.00	0.035	5.00	5.00
Squaw	SQW160L	SQW160N	SQW155N	TCHANNEL	284.00	276.00	1463	0.000	0.000	0.000	1.00	1.00	0.035	5.00	5.00
Squaw	SQW210L	SQW210N	SQW205N	TCHANNEL	233.50	233.00	739	0.000	0.000	0.000	1.00	1.00	0.035	5.00	5.00
Squaw	SQW220L	SQW220N	SQW215N	TCHANNEL	233.50	233.50	74	0.000	0.000	0.000	1.00	1.00	0.035	5.00	5.00
Squaw	SQW245L	SQW245N	SQW240N	TCHANNEL	240.00	236.00	891	0.000	0.000	0.000	1.00	1.00	0.035	5.00	5.00
Squaw	SQWOUTL	SQWOUTN	SQWENDN	TCHANNEL	205.50	200.00	57	0.000	0.000	0.000	1.00	1.00	0.035	10.00	10.00
North	NOR007L	NOR007N	NOR005N	NCHANNEL	240.00	217.64	3270	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
North	NOR010L	NOR010N	NOR007N	NCHANNEL	262.58	240.00	1667	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
North	NOR020L	NOR020N	NOR015N	NCHANNEL	293.53	263.24	1818	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
North	NOR030L	NOR030N	NOR025N	NCHANNEL	380.00	294.05	4185	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
North	NOR035L	NOR035N	NOR030N	NCHANNEL	566.00	380.00	3326	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
North	NOR050L	NOR050N	NOR005N	NCHANNEL	242.00	217.64	3207	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
North	NOR055L	NOR055N	NOR050N	NCHANNEL	261.00	242.00	3065	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
North	NOR065L	NOR065N	NOR060N	NCHANNEL	310.81	261.52	3967	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
North	NOR075L	NOR075N	NOR070N	NCHANNEL	370.00	311.67	2246	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
North	NOR080L	NOR080N	NOR075N	NCHANNEL	430.00	370.00	1638	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00

Table A-4. Open Channel Parameters

Basin	Name	Upstream Node	Downstream Node	Conduit Type	US Invert Elev., ft	DS Invert Elev., ft	Length, ft	Left Bank Roughness	Channel Roughness	Right Bank Roughness	Left Bank Slope	Right Bank Slope	Channel Roughness	Depth, ft	Width, ft
North	NOR085L	NOR085N	NOR050N	TCHANNEL	324.00	242.00	4717	0.000	0.000	0.000	0.50	0.50	0.035	7.00	5.00
North	NOR090L	NOR090N	NOR085N	TCHANNEL	368.00	324.00	1565	0.000	0.000	0.000	0.50	0.50	0.035	5.00	5.00
North	NOR095L	NOR095N	NOR090N	TCHANNEL	508.00	368.00	2269	0.000	0.000	0.000	0.50	0.50	0.035	5.00	5.00
Village Green	VLG020L	VLG020N	VLG015N	NCHANNEL	207.34	206.10	1570	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
Village Green	VLG030L	VLG030N	VLG025N	NCHANNEL	208.70	207.60	618	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
Village Green	VLG040L	VLG040N	VLG035N	NCHANNEL	210.00	209.00	1177	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
Village Green	VLG000L	VLG000N	VLGOUTN	TCHANNEL	204.00	200.00	735	0.000	0.000	0.000	1.00	1.00	0.035	5.00	5.00
Village Green	VLG010L	VLG010N	VLG005N	TCHANNEL	206.00	204.10	343	0.000	0.000	0.000	1.00	1.00	0.035	5.00	5.00
Sequoia	SEQ100L	SEQ100N	SEQ025N	NCHANNEL	213.60	212.49	1167	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
Sequoia	SEQ105L	SEQ115N	SEQ100N	NCHANNEL	213.81	213.60	724	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
Sequoia	SEQ155L	SEQ155N	SEQ120N	NCHANNEL	218.00	214.53	840	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
Sequoia	SEQ165L	SEQ165N	SEQ160N	NCHANNEL	218.40	218.20	865	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
Sequoia	SEQ290L	SEQ290N	SEQ185N	NCHANNEL	238.00	223.02	653	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
Sequoia	SEQ000L	SEQ000N	SEQOUTN	TCHANNEL	201.00	200.00	1355	0.000	0.000	0.000	1.00	1.00	0.035	5.00	10.00
Sequoia	SEQ020L	SEQ020N	SEQ005N	TCHANNEL	212.30	201.10	2872	0.000	0.000	0.000	1.00	1.00	0.035	5.00	10.00
Sequoia	SEQ030L	SEQ030N	SEQ025N	TCHANNEL	213.56	212.49	534	0.000	0.000	0.000	1.00	1.00	0.035	5.00	5.00
Sequoia	SEQ125L	SEQ125N	SEQ120N	TCHANNEL	222.00	214.53	562	0.000	0.000	0.000	1.00	1.00	0.035	5.00	5.00
Sequoia	SEQ140L	SEQ140N	SEQ130N	TCHANNEL	225.90	222.20	1063	0.000	0.000	0.000	1.00	1.00	0.035	5.00	5.00
Sequoia	SEQ150L	SEQ150N	SEQ145N	TCHANNEL	228.00	226.00	663	0.000	0.000	0.000	1.00	1.00	0.035	5.00	5.00
Sequoia	SEQ190L	SEQ190N	SEQ165N	TCHANNEL	220.10	218.40	1334	0.000	0.000	0.000	1.00	1.00	0.035	5.00	5.00
Sequoia	SEQ310L	SEQ310N	SEQ290N	TCHANNEL	243.80	238.00	454	0.000	0.000	0.000	1.00	1.00	0.035	5.00	5.00
Sequoia	SEQ320L	SEQ320N	SEQ315N	TCHANNEL	250.30	244.00	286	0.000	0.000	0.000	1.00	1.00	0.035	5.00	5.00
Sequoia	SEQ330L	SEQ330N	SEQ325N	TCHANNEL	257.80	250.50	336	0.000	0.000	0.000	1.00	1.00	0.035	5.00	5.00
Sequoia	SEQ340L	SEQ340N	SEQ335N	TCHANNEL	292.18	258.00	717	0.000	0.000	0.000	1.00	1.00	0.035	5.00	5.00
Garfield	GAR010L	GAR010N	GAR005N	NCHANNEL	212.00	202.75	1453	0.035	0.020	0.035	0.00	0.00	0.000	0.00	0.00
Garfield	GAR015L	GAR015N	GAR010N	NCHANNEL	214.44	212.00	1634	0.035	0.020	0.035	0.00	0.00	0.000	0.00	0.00
Garfield	GAR025L	GAR025N	GAR020N	NCHANNEL	214.86	214.49	748	0.035	0.020	0.035	0.00	0.00	0.000	0.00	0.00
Garfield	GAR035L	GAR035N	GAR030N	NCHANNEL	215.70	214.92	450	0.035	0.020	0.035	0.00	0.00	0.000	0.00	0.00
Garfield	GAR040L	GAR040N	GAR030N	NCHANNEL	216.63	214.92	470	0.035	0.020	0.035	0.00	0.00	0.000	0.00	0.00
Garfield	GAR000L	GAR000N	GAR999N	TCHANNEL	200.23	195.23	100	0.000	0.000	0.000	1.00	1.00	0.013	5.00	5.00
Oak	OAK005L	OAK005N	OAKOUTN	NCHANNEL	200.00	198.00	342	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
Oak	OAK015L	OAK015N	OAK010N	NCHANNEL	202.75	202.48	153	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
Oak	OAK033L	OAK033N	OAK030N	NCHANNEL	211.00	210.00	778	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
Oak	OAK045L	OAK045N	OAK040N	NCHANNEL	218.00	217.00	738	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
Oak	OAK060L	OAK060N	OAK045N	NCHANNEL	220.00	218.00	1143	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
Oak	OAK090L	OAK090N	OAK085N	NCHANNEL	230.86	225.00	1301	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
Oak	OAK103L	OAK103N	OAK100N	NCHANNEL	252.00	242.34	1368	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
Oak	OAK105L	OAK105N	OAK103N	NCHANNEL	259.50	252.00	1322	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00

Table A-4. Open Channel Parameters

Basin	Name	Upstream Node	Downstream Node	Conduit Type	US Invert Elev., ft	DS Invert Elev., ft	Length, ft	Left Bank Roughness	Channel Roughness	Right Bank Roughness	Left Bank Slope	Right Bank Slope	Channel Roughness	Depth, ft	Width, ft
Oak	OAK110L	OAK110N	OAK105N	NCHANNEL	261.80	259.50	684	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
Oak	OAK120L	OAK120N	OAK115N	NCHANNEL	264.50	262.30	196	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
Oak	OAK125L	OAK125N	OAK120N	NCHANNEL	265.00	264.50	120	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
Oak	OAK140L	OAK140N	OAK135N	NCHANNEL	278.50	266.00	2099	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
Oak	OAK150L	OAK150N	OAK145N	NCHANNEL	298.00	279.00	1264	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
Oak	OAK170L	OAK170N	OAK160N	NCHANNEL	322.82	299.96	2254	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
Oak	OAK205L	OAK205N	OAK170N	NCHANNEL	370.00	322.82	4933	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
Oak	OAK235L	OAK235N	OAK120N	NCHANNEL	280.00	264.50	1530	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
Oak	OAK255L	OAK255N	OAK105N	NCHANNEL	268.55	259.50	1044	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
Oak	OAK280L	OAK280N	OAK245N	NCHANNEL	334.88	296.00	1967	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
Oak	OAK290L	OAK290N	OAK285N	NCHANNEL	362.00	335.36	1220	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
Oak	OAK350L	OAK350N	OAK090N	NCHANNEL	234.15	230.86	343	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
Oak	OAK025L	OAK025N	OAK020N	TCHANNEL	209.50	203.00	855	0.000	0.000	0.000	1.60	1.70	0.035	17.50	20.00
Oak	OAK035L	OAK035N	OAK033N	TCHANNEL	216.00	211.00	310	0.000	0.000	0.000	0.46	1.00	0.035	17.50	21.00
Oak	OAK080L	OAK080N	OAK065N	TCHANNEL	224.50	221.00	798	0.000	0.000	0.000	1.60	1.50	0.035	9.00	16.00
Oak	OAK100L	OAK100N	OAK090N	TCHANNEL	242.34	230.86	2087	0.000	0.000	0.000	1.00	1.00	0.035	7.85	10.00
Oak	OAK130L	OAK130N	OAK125N	TCHANNEL	265.50	265.00	194	0.000	0.000	0.000	1.60	0.97	0.035	6.20	14.00
Oak	OAK155L	OAK155N	OAK150N	TCHANNEL	299.50	298.00	1379	0.000	0.000	0.000	1.10	1.70	0.035	7.00	17.00
Oak	OAK215L	OAK215N	OAK205N	TCHANNEL	390.00	370.00	949	0.000	0.000	0.000	1.30	1.70	0.035	6.00	10.00
Oak	OAK225L	OAK225N	OAK125N	TCHANNEL	268.00	265.00	69	0.000	0.000	0.000	1.60	0.97	0.035	6.20	14.00
Oak	OAK245L	OAK245N	OAK235N	TCHANNEL	296.00	280.00	1410	0.000	0.000	0.000	2.50	4.75	0.035	4.00	24.00
Goodnight	GDN185b	GDN185N	GDN030N	TCHANNEL	235.00	228.23	122	0.000	0.000	0.000	1.00	1.00	0.035	5.00	5.00
Goodnight	GDN555L	GDN555N	GDN190N	TCHANNEL	232.00	232.00	280	0.000	0.000	0.000	1.00	1.00	0.035	1.00	1.00
Goodnight	GDN565L	GDN565N	GDN560N	TCHANNEL	232.60	232.00	803	0.000	0.000	0.000	1.00	1.00	0.035	1.00	1.00
Goodnight	GDN575L	GDN575N	GDN570N	TCHANNEL	233.30	232.70	518	0.000	0.000	0.000	1.00	1.00	0.035	1.50	1.00
Goodnight	GDN580L	GDN580N	GDN575N	TCHANNEL	232.90	233.30	324	0.000	0.000	0.000	1.00	1.00	0.035	1.00	1.00
Goodnight	GDN585L	GDN585N	GDN580N	TCHANNEL	233.00	232.90	359	0.000	0.000	0.000	1.00	1.00	0.035	1.20	1.00
Mill Race	MIL025L	MIL025N	MIL020N	NCHANNEL	198.50	204.00	314	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
Mill Race	MIL040L	MIL040N	MIL030N	NCHANNEL	208.00	199.00	956	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
Mill Race	MIL050L	MIL050N	MIL045N	NCHANNEL	208.46	208.26	342	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
Mill Race	MIL055L	MIL055N	MIL050N	NCHANNEL	208.63	208.46	307	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
Mill Race	MIL075L	MIL075N	MIL060N	NCHANNEL	208.00	208.70	1379	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
Mill Race	MIL085L	MIL085N	MIL080N	NCHANNEL	210.17	208.11	1036	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
Mill Race	MIL090L	MIL090N	MIL085N	NCHANNEL	210.79	210.17	310	0.070	0.035	0.070	0.00	0.00	0.000	0.00	0.00
Mill Race	MIL005L	MIL005N	MILOUTN	TCHANNEL	202.75	194.75	445	0.000	0.000	0.000	1.60	1.60	0.035	8.00	16.00
Mill Race	MIL015L	MIL015N	MIL010N	TCHANNEL	203.30	203.25	32	0.000	0.000	0.000	1.80	1.10	0.035	8.00	20.00

TABLE A-5

MODEL RESULTS – FLOW

Table A-5. Model Results - Flows

			Present Flows, cfs					Future Flows, cfs				
Basin	Name	Capacity, cfs	2-year	5-year	10-year	25-year	100-year	2-year	5-year	10-year	25-year	100-year
Dixon	DIX220L	2730.00	384.00	447.00	553.00	586.00	673.00	394.00	457.00	559.00	597.00	675.00
Dixon	DIX230L	17000.00	390.00	453.00	556.00	592.00	683.00	400.00	464.00	561.00	602.00	684.00
Dixon	DIX240L	8660.00	387.00	451.00	558.00	592.00	680.00	397.00	461.00	562.00	602.00	681.00
Dixon	DIX250L	12100.00	385.00	451.00	555.00	590.00	677.00	394.00	458.00	562.00	599.00	680.00
Dixon	DIX260L	41.00	29.00	30.70	31.00	31.40	35.50	29.00	30.60	31.10	31.40	35.70
Dixon	DIX265L	32.00	29.00	30.90	30.90	30.90	35.30	29.10	30.90	30.90	30.90	35.60
Dixon	DIX270L	34.00	29.00	31.00	30.90	31.00	35.30	29.10	30.90	31.00	30.90	35.60
Dixon	DIX275L	29.00	29.00	30.90	30.90	30.90	30.90	29.10	30.90	31.00	30.90	30.90
Dixon	DIX280L	30.00	29.00	30.90	30.90	30.90	30.90	29.10	30.90	30.90	30.90	30.90
Dixon	DIX285L	30.00	29.00	30.90	30.90	30.90	30.90	29.10	30.90	30.90	30.90	30.90
Dixon	DIX290L	31.00	29.00	30.90	30.90	30.90	30.90	29.10	30.90	31.00	30.90	30.90
Dixon	DIX295L	12.00	8.34	8.60	12.90	11.20	13.40	8.34	8.57	12.90	11.20	13.40
Dixon	DIX300L	10.00	8.29	8.60	13.00	11.20	13.40	8.29	8.56	13.00	11.30	13.40
Dixon	DIX305L	11.00	8.24	8.59	12.90	11.20	13.40	8.25	8.56	12.90	11.40	13.40
Dixon	DIX310L	8.20	8.19	8.25	8.56	8.38	8.85	8.19	8.25	8.57	8.38	8.85
Dixon	DIX315L	8.70	8.19	8.25	8.56	8.38	8.85	8.19	8.25	8.57	8.38	8.85
Dixon	DIX320L	7.40	8.19	8.25	8.30	8.36	8.36	8.19	8.25	8.30	8.36	8.37
Dixon	DIX325L	7.30	8.19	8.25	8.30	8.39	8.40	8.22	8.25	8.30	8.39	8.42
Dixon	DIX330L	14.00	9.56	9.56	9.56	9.58	9.57	9.56	9.56	9.56	9.58	9.57
Dixon	DIX335L	14.00	12.30	12.30	12.30	12.30	12.30	12.30	12.30	12.30	12.30	12.30
Dixon	DIX340L	14.00	13.10	14.80	14.80	14.80	14.80	13.10	14.80	14.80	14.80	14.80
Dixon	DIX345L	86.00	7.69	9.09	11.90	13.30	16.10	9.09	10.60	13.70	15.20	18.30
Dixon	DIX350L	48.00	7.68	9.08	11.90	13.20	16.00	9.07	10.60	13.70	15.20	18.30
Dixon	DIX355L	91.00	7.71	9.11	11.90	13.30	16.10	9.17	10.70	13.80	15.40	18.60
Dixon	DIX360L	47.00	24.60	28.60	38.40	39.70	40.10	24.30	28.80	38.40	39.70	40.20
Dixon	DIX365L	51.00	22.10	25.50	34.10	37.50	41.60	22.10	25.70	34.10	37.50	41.60
Dixon	DIX370L	73.00	22.60	26.30	34.00	37.50	45.00	22.70	26.30	34.00	37.50	45.00
Dixon	DIX375L	77.00	22.50	26.30	36.20	38.30	45.00	22.50	26.40	36.30	38.50	45.00
Dixon	DIX380L	120.00	19.80	23.20	30.00	33.30	40.10	19.80	23.20	29.90	33.30	40.10
Dixon	DIX385L	129.00	19.80	23.20	30.00	33.40	40.20	19.80	23.20	30.00	33.40	40.20
Dixon	DIX390L	144.00	9.16	10.70	13.80	15.30	18.50	9.16	10.70	13.80	15.30	18.50
Dixon	DIX395L	34.00	46.20	53.10	62.30	60.90	69.30	46.00	53.50	61.90	60.60	69.60
Dixon	DIX400L	58.00	21.70	24.70	33.00	34.60	36.10	21.80	25.00	33.20	35.10	36.20
Dixon	DIX405L	58.00	21.20	23.40	29.60	31.10	32.80	21.40	23.50	29.90	31.00	32.80
Dixon	DIX410L	83.00	20.00	23.30	30.10	33.40	40.20	20.20	23.50	30.30	33.70	40.50

Table A-5. Model Results - Flows

			Present Flows, cfs					Future Flows, cfs				
Basin	**Name**	**Capacity, cfs**	**2-year**	**5-year**	**10-year**	**25-year**	**100-year**	**2-year**	**5-year**	**10-year**	**25-year**	**100-year**
Dixon	DIX415L	85.00	14.20	16.70	21.30	23.90	29.10	14.40	16.90	21.50	24.10	29.40
Dixon	DIX420L	27.00	15.60	18.40	22.90	22.90	23.10	17.00	20.00	22.70	22.70	22.80
Dixon	DIX425L	27.00	12.70	14.90	17.90	17.50	18.10	14.10	16.50	17.80	17.90	18.10
Dixon	DIX430L	25.00	12.80	14.90	17.90	17.60	18.10	14.20	16.50	17.90	17.80	18.10
Dixon	DIX435L	18.00	13.10	15.30	18.70	18.40	17.90	14.70	16.90	18.70	18.50	18.10
Dixon	DIX440L	22.00	5.20	6.10	8.00	8.91	10.80	6.06	7.17	9.24	10.30	12.30
Dixon	DIX445L	21.00	5.23	6.12	8.05	8.91	10.80	6.08	7.22	9.26	10.30	12.50
Dixon	DIX450L	22.00	5.27	6.13	8.09	8.94	10.80	6.07	7.25	9.30	10.30	12.40
Dixon	DIX455L	30.00	5.30	6.18	8.10	8.99	10.90	6.05	7.28	9.35	10.40	12.50
Dixon	DIX460L	30.00	5.24	6.17	8.01	8.94	10.80	6.05	7.21	9.30	10.30	12.50
Dixon	DIX465L	37.00	5.17	6.12	8.00	8.94	10.80	6.10	7.16	9.28	10.30	12.50
Dixon	DIX480L	4160.00	384.00	447.00	553.00	586.00	673.00	394.00	457.00	559.00	597.00	674.00
Dixon	DIX490L	4270.00	372.00	433.00	535.00	568.00	651.00	380.00	441.00	540.00	579.00	655.00
Dixon	DIX500L	2010.00	372.00	433.00	535.00	568.00	651.00	380.00	441.00	540.00	579.00	655.00
Dixon	DIX510L	2710.00	371.00	431.00	533.00	567.00	649.00	379.00	440.00	538.00	578.00	653.00
Dixon	DIX520L	1640.00	369.00	430.00	531.00	565.00	647.00	378.00	438.00	536.00	576.00	651.00
Dixon	DIX530L	1710.00	358.00	417.00	514.00	549.00	633.00	367.00	426.00	519.00	560.00	637.00
Dixon	DIX540L	1010.00	334.00	391.00	484.00	519.00	610.00	343.00	399.00	491.00	533.00	615.00
Dixon	DIX555L	1300.00	333.00	390.00	482.00	518.00	610.00	342.00	398.00	488.00	532.00	615.00
Dixon	DIX565L	2170.00	326.00	383.00	473.00	508.00	613.00	336.00	390.00	478.00	526.00	618.00
Dixon	DIX570L	1120.00	322.00	377.00	465.00	506.00	604.00	331.00	384.00	471.00	520.00	610.00
Dixon	DIX580L	3510.00	303.00	354.00	439.00	483.00	570.00	313.00	361.00	444.00	496.00	576.00
Dixon	DIX585L	670.00	300.00	350.00	435.00	479.00	565.00	308.00	358.00	440.00	491.00	571.00
Dixon	DIX595L	3010.00	288.00	335.00	415.00	460.00	546.00	296.00	342.00	432.00	472.00	553.00
Dixon	DIX605L	4130.00	249.00	288.00	358.00	405.00	494.00	256.00	294.00	363.00	418.00	501.00
Dixon	DIX613L	157.00	246.00	284.00	354.00	401.00	489.00	253.00	291.00	358.00	414.00	495.00
Dixon	DIX615L	3590.00	244.00	281.00	350.00	398.00	485.00	250.00	287.00	355.00	410.00	491.00
Dixon	DIX625L	483.00	243.00	280.00	350.00	400.00	485.00	250.00	287.00	355.00	412.00	492.00
Dixon	DIX630L	7400.00	239.00	275.00	343.00	398.00	478.00	245.00	282.00	348.00	408.00	485.00
Dixon	DIX640L	328.00	65.40	76.40	98.40	108.00	130.00	66.70	77.80	100.00	110.00	132.00
Dixon	DIX650L	175.00	58.90	68.80	88.60	97.60	117.00	59.80	69.80	89.70	98.70	118.00
Dixon	DIX660L	3900.00	54.20	63.30	81.80	90.70	109.00	54.40	63.50	82.00	90.90	110.00
Dixon	DIX665L	6880.00	237.00	273.00	341.00	396.00	475.00	244.00	280.00	346.00	406.00	482.00
Dixon	DIX670L	195.00	67.60	78.50	102.00	111.00	131.00	70.10	81.10	105.00	112.00	134.00
Dixon	DIX680L	366.00	7.62	9.01	11.80	13.10	15.90	8.81	10.30	13.30	14.60	17.60

Table A-5. Model Results - Flows

			Present Flows, cfs					Future Flows, cfs				
Basin	**Name**	**Capacity, cfs**	**2-year**	**5-year**	**10-year**	**25-year**	**100-year**	**2-year**	**5-year**	**10-year**	**25-year**	**100-year**
Dixon	DIX690L	116.00	7.65	9.04	11.80	13.20	15.90	8.92	10.40	13.40	14.80	17.90
Dixon	DIX695L	4200.00	67.40	78.70	102.00	112.00	132.00	69.90	81.10	104.00	113.00	134.00
Dixon	DIX698L	65.00	59.70	70.40	91.00	101.00	123.00	61.60	72.60	93.30	106.00	125.00
Dixon	DIX700L	344.00	56.30	66.30	86.60	96.20	116.00	58.30	68.40	88.80	98.70	119.00
Dixon	DIX710L	436.00	19.50	23.00	30.10	33.60	40.70	20.50	24.10	31.30	34.90	42.20
Dixon	DIX715L	535.00	18.90	22.30	29.10	32.50	39.30	19.90	23.30	30.30	33.80	40.80
Dixon	DIX720L	447.00	17.40	20.60	26.90	30.10	36.40	18.40	21.60	28.10	31.30	37.90
Dixon	DIX725L	340.00	14.30	17.00	22.20	24.80	30.10	15.20	17.90	23.30	26.00	31.50
Dixon	DIX735L	456.00	24.50	28.80	37.70	41.90	50.80	25.10	29.50	38.40	42.80	51.80
Dixon	DIX740L	507.00	21.60	25.50	33.30	37.10	44.90	22.30	26.20	34.00	37.90	45.80
Dixon	DIX745L	623.00	21.20	25.00	32.60	36.30	44.00	21.80	25.70	33.30	37.20	44.90
Dixon	DIX750L	321.00	16.00	18.90	24.80	27.60	33.50	16.60	19.50	25.40	28.40	34.40
Dixon	DIX760L	439.00	19.90	23.50	30.70	34.20	41.50	20.60	24.20	31.40	35.10	42.40
Dixon	DIX775L	479.00	3.41	3.99	5.18	5.74	6.95	3.49	4.09	5.27	5.86	7.08
Dixon	DIX785L	4840.00	54.90	64.60	84.40	93.90	114.00	56.90	66.80	86.70	96.50	117.00
Dixon	DIX790L	516.00	7.00	8.18	10.50	11.70	14.10	7.36	8.57	10.90	12.20	14.60
Dixon	DIX795L	542.00	5.42	6.32	8.09	9.04	10.90	5.87	6.83	8.72	9.72	11.70
Dixon	DIX805L	414.00	175.00	204.00	246.00	301.00	354.00	179.00	207.00	250.00	301.00	357.00
Dixon	DIX810L	391.00	109.00	131.00	147.00	209.00	227.00	110.00	131.00	148.00	208.00	228.00
Dixon	DIX815L	253.00	104.00	124.00	136.00	205.00	212.00	105.00	125.00	136.00	205.00	212.00
Dixon	DIX820L	300.00	103.00	122.00	132.00	229.00	238.00	103.00	123.00	132.00	234.00	253.00
Dixon	DIX825L	314.00	103.00	123.00	134.00	258.00	267.00	104.00	124.00	134.00	264.00	285.00
Dixon	DIX835L	339.00	94.10	112.00	152.00	210.00	215.00	94.80	114.00	163.00	213.00	227.00
Dixon	DIX845L	3660.00	79.60	96.40	123.00	138.00	166.00	80.20	97.30	124.00	139.00	167.00
Dixon	DIX855L	12600.00	81.20	95.30	121.00	135.00	164.00	82.10	96.40	122.00	137.00	166.00
Dixon	DIX865L	2400.00	72.30	84.80	109.00	120.00	146.00	72.70	85.20	109.00	121.00	148.00
Dixon	DIX874L	475.00	71.20	83.90	109.00	121.00	146.00	71.70	84.50	110.00	122.00	147.00
Dixon	DIX875L	583.00	1.94	2.28	2.96	3.29	3.98	2.18	2.55	3.28	3.63	4.39
Dixon	DIX885L	398.00	69.50	81.90	107.00	119.00	143.00	70.00	82.60	107.00	119.00	144.00
Dixon	DIX890L	393.00	64.00	75.50	98.40	109.00	132.00	64.50	76.00	98.90	110.00	132.00
Dixon	DIX895L	682.00	4.06	4.76	6.19	6.85	8.23	4.24	4.95	6.38	7.08	8.48
Dixon	DIX905L	522.00	2.79	3.26	4.21	4.68	5.64	2.88	3.35	4.31	4.79	5.76
Dixon	DIX915L	3270.00	60.10	70.90	92.40	103.00	123.00	60.40	71.20	92.70	103.00	124.00
Dixon	DIX925L	398.00	58.90	69.50	90.50	101.00	121.00	59.20	69.80	90.80	101.00	122.00
Dixon	DIX930L	486.00	41.40	49.00	64.10	71.70	87.00	41.40	49.00	64.10	71.70	87.00

Table A-5. Model Results - Flows

			Present Flows, cfs					Future Flows, cfs				
Basin	**Name**	**Capacity, cfs**	**2-year**	**5-year**	**10-year**	**25-year**	**100-year**	**2-year**	**5-year**	**10-year**	**25-year**	**100-year**
Dixon	DIX935L	466.00	4.01	4.69	6.07	6.75	8.15	4.23	4.92	6.33	7.03	8.46
Dixon	DIX945L	492.00	13.30	15.60	20.10	21.80	25.60	13.50	15.80	20.30	22.10	26.00
Dixon	DIX950L	505.00	8.58	10.00	12.70	13.60	16.20	8.57	10.00	12.70	13.60	16.20
Dixon	DIX955L	224.00	8.58	10.00	12.70	13.60	16.30	8.58	10.00	12.70	13.60	16.20
Dixon	DIX960L	638.00	6.77	7.93	10.10	10.90	13.00	6.77	7.93	10.10	10.90	13.00
Dixon	DIX970L	679.00	6.81	7.98	10.10	11.00	13.20	6.81	7.98	10.10	11.00	13.20
Dixon	DIX995L	553.00	6.11	7.19	9.35	10.40	12.60	6.11	7.19	9.35	10.40	12.60
Dixon	DIXOUTL	2640.00	389.00	452.00	555.00	593.00	683.00	398.00	461.00	559.00	601.00	683.00
Dixon	DIX225A	2330.00	192.00	224.00	278.00	294.00	337.00	197.00	229.00	281.00	300.00	339.00
Dixon	DIX225O	3820.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX235A	2410.00	390.00	454.00	561.00	595.00	685.00	400.00	464.00	566.00	605.00	687.00
Dixon	DIX235O	4540.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX245A	1990.00	388.00	451.00	558.00	592.00	681.00	397.00	461.00	563.00	602.00	682.00
Dixon	DIX245O	5740.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX255A	2260.00	384.00	447.00	553.00	586.00	673.00	394.00	457.00	559.00	597.00	675.00
Dixon	DIX255O	3850.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX475A	1400.00	389.00	451.00	555.00	593.00	683.00	398.00	460.00	560.00	600.00	684.00
Dixon	DIX475O	5420.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX485A	2110.00	384.00	447.00	553.00	586.00	673.00	394.00	457.00	559.00	597.00	674.00
Dixon	DIX485O	4990.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX495A	4000.00	372.00	433.00	535.00	568.00	651.00	380.00	441.00	540.00	579.00	655.00
Dixon	DIX495O	9460.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX505A	1250.00	372.00	433.00	535.00	569.00	652.00	380.00	441.00	541.00	580.00	655.00
Dixon	DIX505O	3290.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX515A	1370.00	371.00	432.00	534.00	567.00	650.00	379.00	440.00	539.00	578.00	653.00
Dixon	DIX515O	4800.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX525A	99.00	365.00	425.00	525.00	559.00	641.00	374.00	433.00	531.00	570.00	644.00
Dixon	DIX525O	4570.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX535A	2020.00	334.00	391.00	485.00	521.00	610.00	343.00	400.00	491.00	533.00	615.00
Dixon	DIX535O	4190.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX545A	2390.00	334.00	391.00	484.00	519.00	611.00	343.00	399.00	489.00	533.00	617.00
Dixon	DIX545O	4800.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX560A	971.00	272.00	322.00	406.00	441.00	531.00	280.00	329.00	411.00	455.00	536.00
Dixon	DIX560B	104.00	60.70	68.40	76.50	77.50	80.10	62.10	69.40	76.70	78.10	80.40
Dixon	DIX560O	4660.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table A-5. Model Results - Flows

			Present Flows, cfs					Future Flows, cfs				
Basin	**Name**	**Capacity, cfs**	**2-year**	**5-year**	**10-year**	**25-year**	**100-year**	**2-year**	**5-year**	**10-year**	**25-year**	**100-year**
Dixon	DIX575A	1170.00	225.00	264.00	331.00	365.00	449.00	231.00	269.00	335.00	378.00	454.00
Dixon	DIX575B	106.00	48.40	56.40	67.40	71.70	78.10	49.90	57.40	68.10	72.50	78.40
Dixon	DIX575O	2970.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX590A	1760.00	300.00	350.00	435.00	479.00	565.00	308.00	358.00	440.00	491.00	571.00
Dixon	DIX590O	3610.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX600A	517.00	249.00	288.00	358.00	405.00	494.00	256.00	294.00	363.00	418.00	501.00
Dixon	DIX600O	2790.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX610A	1790.00	249.00	288.00	358.00	406.00	494.00	256.00	294.00	363.00	418.00	501.00
Dixon	DIX610O	3870.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX620A	1460.00	244.00	281.00	351.00	400.00	462.00	250.00	287.00	355.00	412.00	463.00
Dixon	DIX620O	6320.00	0.00	0.00	0.00	0.00	40.60	0.00	0.00	0.00	0.00	46.80
Dixon	DIX635A	1080.00	239.00	275.00	343.00	399.00	478.00	246.00	282.00	349.00	408.00	485.00
Dixon	DIX635O	3990.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX645A	303.00	31.00	36.20	46.80	51.50	61.60	31.60	36.80	47.50	52.00	62.40
Dixon	DIX645O	3340.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX655A	349.00	59.00	68.90	88.70	97.70	117.00	60.00	69.90	89.80	98.80	118.00
Dixon	DIX655O	4020.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX675A	310.00	67.70	78.70	102.00	111.00	131.00	70.10	81.20	105.00	112.00	134.00
Dixon	DIX675O	3400.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX685A	70.00	7.63	9.01	11.80	13.10	15.90	8.84	10.30	13.30	14.70	17.60
Dixon	DIX685O	2790.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX705A	309.00	55.40	65.30	85.30	94.70	114.00	57.40	67.40	87.60	97.30	117.00
Dixon	DIX705O	1410.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX730A	12.00	8.99	9.38	10.30	10.80	11.60	9.13	9.55	10.50	10.90	11.80
Dixon	DIX730O	1680.00	3.79	5.72	9.44	11.30	15.20	4.20	6.13	9.92	11.80	15.80
Dixon	DIX755A	43.00	16.10	19.00	24.20	25.90	28.50	16.70	19.70	24.70	26.40	28.70
Dixon	DIX755O	2390.00	0.00	0.00	0.65	1.82	5.20	0.00	0.00	0.91	2.18	5.81
Dixon	DIX780A	12.00	3.42	4.01	5.19	5.73	6.39	3.51	4.10	5.29	5.81	6.44
Dixon	DIX780O	1680.00	0.00	0.00	0.00	0.02	0.59	0.00	0.00	0.00	0.06	0.66
Dixon	DIX800A	20.00	5.44	6.35	8.04	8.55	9.32	5.96	6.93	8.42	8.87	9.61
Dixon	DIX800O	2260.00	0.00	0.00	0.07	0.52	1.62	0.00	0.00	0.40	0.97	2.27
Dixon	DIX830A	62.00	58.60	62.00	90.40	93.90	92.60	58.70	62.20	91.80	94.50	95.90
Dixon	DIX830O	1100.00	42.60	58.50	129.00	189.00	197.00	43.20	59.70	174.00	196.00	216.00
Dixon	DIX840A	377.00	83.50	100.00	133.00	178.00	173.00	84.20	101.00	140.00	177.00	178.00
Dixon	DIX840O	2930.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.82

Table A-5. Model Results - Flows

			Present Flows, cfs					Future Flows, cfs				
Basin	Name	Capacity, cfs	2-year	5-year	10-year	25-year	100-year	2-year	5-year	10-year	25-year	100-year
Dixon	DIX850A	132.00	79.60	89.80	99.90	105.00	114.00	80.20	90.20	100.00	105.00	114.00
Dixon	DIX850O	2830.00	0.00	6.56	23.10	32.90	52.20	0.00	7.10	23.70	33.60	53.00
Dixon	DIX860A	186.00	79.50	93.30	118.00	129.00	132.00	80.40	94.30	119.00	130.00	132.00
Dixon	DIX860O	2800.00	0.00	0.00	0.00	3.75	28.90	0.00	0.00	0.10	4.40	30.60
Dixon	DIX870A	80.00	70.00	82.10	105.00	116.00	140.00	70.30	82.40	105.00	117.00	141.00
Dixon	DIX870O	5930.00	0.00	0.00	0.00	0.00	1.31	0.00	0.00	0.00	0.00	2.18
Dixon	DIX880A	78.00	1.96	2.30	2.98	3.32	4.01	2.24	2.61	3.37	3.73	4.50
Dixon	DIX880O	3080.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX900A	49.00	4.06	4.76	6.19	6.85	8.23	4.24	4.95	6.38	7.07	8.47
Dixon	DIX900O	4480.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX910A	22.00	2.81	3.28	4.23	4.71	5.67	2.90	3.38	4.34	4.82	5.80
Dixon	DIX910O	1160.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX920A	29.00	22.10	23.70	26.60	27.80	30.10	22.10	23.80	26.60	27.90	30.20
Dixon	DIX920O	1530.00	36.70	45.70	63.90	72.60	90.80	37.00	46.00	64.10	73.00	91.20
Dixon	DIX940A	42.00	4.02	4.70	6.08	6.77	8.16	4.23	4.93	6.34	7.05	8.48
Dixon	DIX940O	2420.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX965A	26.00	6.78	7.94	10.10	10.90	13.00	6.78	7.94	10.10	10.90	13.00
Dixon	DIX965O	3080.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX975A	33.00	6.81	7.98	10.10	11.00	13.20	6.81	7.98	10.10	11.00	13.20
Dixon	DIX975O	3830.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Squaw	SQW005L	473.00	167.00	169.00	172.00	173.00	176.00	167.00	169.00	172.00	174.00	176.00
Squaw	SQW006L	450.00	163.00	164.00	165.00	165.00	166.00	163.00	164.00	165.00	166.00	166.00
Squaw	SQW007L	230.00	162.00	162.00	162.00	162.00	162.00	162.00	162.00	162.00	162.00	162.00
Squaw	SQW008L	184.00	162.00	162.00	162.00	162.00	162.00	162.00	162.00	162.00	163.00	162.00
Squaw	SQW010L	215.00	174.00	174.00	174.00	174.00	176.00	174.00	174.00	174.00	174.00	175.00
Squaw	SQW015L	458.00	231.00	231.00	232.00	232.00	233.00	231.00	231.00	232.00	233.00	233.00
Squaw	SQW021L	612.00	232.00	234.00	236.00	237.00	238.00	232.00	234.00	236.00	237.00	238.00
Squaw	SQW022L	279.00	229.00	231.00	232.00	232.00	236.00	230.00	231.00	232.00	233.00	235.00
Squaw	SQW023L	378.00	231.00	268.00	269.00	269.00	269.00	238.00	268.00	269.00	269.00	269.00
Squaw	SQW024L	1670.00	231.00	291.00	380.00	416.00	472.00	239.00	300.00	386.00	440.00	474.00
Squaw	SQW025L	1040.00	235.00	291.00	380.00	416.00	472.00	243.00	300.00	386.00	440.00	474.00
Squaw	SQW035L	1720.00	233.00	287.00	373.00	408.00	460.00	242.00	297.00	379.00	435.00	465.00
Squaw	SQW040L	854.00	136.00	155.00	194.00	207.00	233.00	138.00	159.00	196.00	206.00	235.00
Squaw	SQW050L	6170.00	124.00	140.00	177.00	189.00	211.00	127.00	143.00	179.00	188.00	213.00
Squaw	SQW060L	1700.00	115.00	131.00	175.00	198.00	228.00	117.00	133.00	179.00	199.00	230.00

Table A-5. Model Results - Flows

			Present Flows, cfs					Future Flows, cfs				
Basin	**Name**	**Capacity, cfs**	**2-year**	**5-year**	**10-year**	**25-year**	**100-year**	**2-year**	**5-year**	**10-year**	**25-year**	**100-year**
Squaw	SQW075L	248.00	26.60	31.20	40.30	44.80	53.90	27.50	32.10	41.30	46.40	57.10
Squaw	SQW080L	232.00	12.30	14.30	18.50	20.90	25.60	13.10	15.70	20.60	23.10	28.10
Squaw	SQW085L	172.00	80.20	92.10	119.00	132.00	161.00	82.00	94.10	121.00	135.00	162.00
Squaw	SQW090L	25.00	6.10	7.17	8.46	8.40	8.40	6.66	7.82	8.44	8.38	8.37
Squaw	SQW095L	14.00	6.11	7.17	8.46	8.40	8.40	6.67	7.82	8.44	8.37	8.37
Squaw	SQW100L	15.00	6.15	7.18	8.45	8.39	8.39	6.69	7.83	8.43	8.37	8.36
Squaw	SQW105L	14.00	6.22	7.29	8.48	8.43	8.42	6.82	7.93	8.41	8.40	8.42
Squaw	SQW110L	9.00	6.25	7.34	8.62	8.59	8.49	6.92	8.07	8.60	8.55	8.51
Squaw	SQW120L	5.40	6.27	7.36	8.62	8.60	8.51	6.98	8.12	8.60	8.57	8.53
Squaw	SQW130L	321.00	62.40	72.10	92.90	104.00	126.00	63.30	73.00	93.90	106.00	127.00
Squaw	SQW140L	737.00	62.40	72.10	92.90	104.00	126.00	63.30	73.00	94.00	107.00	127.00
Squaw	SQW150L	200.00	56.40	66.40	86.30	96.00	109.00	57.10	67.30	86.90	96.70	110.00
Squaw	SQW155L	356.00	29.70	34.70	44.60	49.50	60.70	29.80	34.90	44.70	50.10	61.40
Squaw	SQW160L	298.00	18.40	21.60	27.70	30.80	37.70	18.50	21.80	27.90	31.30	38.50
Squaw	SQW165L	686.00	7.75	9.25	11.90	13.30	16.00	7.76	9.25	11.90	13.30	16.00
Squaw	SQW170L	25.00	2.32	2.84	8.70	11.90	21.80	2.90	3.64	9.03	12.70	22.10
Squaw	SQW175L	24.00	2.37	2.87	5.03	5.56	11.80	2.93	3.65	5.16	6.21	11.20
Squaw	SQW180L	20.00	2.52	2.99	4.07	4.50	7.78	3.05	3.68	4.65	5.17	8.77
Squaw	SQW185L	18.00	2.55	3.09	3.85	4.29	5.13	3.15	3.76	4.70	5.22	6.18
Squaw	SQW190L	17.00	2.57	3.01	3.90	4.34	5.22	3.18	3.76	4.77	5.29	6.48
Squaw	SQW195L	12.00	2.60	3.04	3.92	4.36	5.25	3.22	3.75	4.81	5.34	6.37
Squaw	SQW200L	3060.00	114.00	133.00	173.00	191.00	231.00	117.00	137.00	177.00	223.00	230.00
Squaw	SQW210L	253.00	110.00	129.00	167.00	184.00	225.00	115.00	132.00	171.00	221.00	224.00
Squaw	SQW220L	13.00	112.00	130.00	168.00	186.00	249.00	117.00	135.00	173.00	234.00	243.00
Squaw	SQW245L	270.00	106.00	124.00	161.00	176.00	210.00	111.00	128.00	166.00	180.00	212.00
Squaw	SQW255L	585.00	77.80	90.90	117.00	130.00	156.00	78.90	92.10	118.00	132.00	162.00
Squaw	SQW270L	13400.00	76.30	87.70	115.00	127.00	152.00	77.20	88.50	116.00	128.00	153.00
Squaw	SQWOUTI	18400.00	168.00	169.00	174.00	173.00	182.00	171.00	169.00	172.00	181.00	180.00
Squaw	SQW000A	8680.00	172.00	169.00	175.00	173.00	189.00	174.00	169.00	172.00	183.00	183.00
Squaw	SQW000O	931.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Squaw	SQW020A	276.00	200.00	203.00	204.00	206.00	206.00	201.00	203.00	204.00	206.00	206.00
Squaw	SQW020O	680.00	31.30	31.50	31.80	31.90	32.00	31.40	31.50	31.80	32.00	32.10
Squaw	SQW030A	1940.00	235.00	291.00	380.00	416.00	473.00	243.00	300.00	386.00	440.00	474.00
Squaw	SQW030O	3970.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Squaw	SQW045A	214.00	43.40	49.70	64.10	69.10	77.90	44.20	50.90	65.10	68.90	78.60

Table A-5. Model Results - Flows

			Present Flows, cfs					Future Flows, cfs				
Basin	**Name**	**Capacity, cfs**	**2-year**	**5-year**	**10-year**	**25-year**	**100-year**	**2-year**	**5-year**	**10-year**	**25-year**	**100-year**
Squaw	SQW045O	629.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Squaw	SQW055A	71.00	37.30	41.90	52.60	56.10	62.90	37.80	42.60	53.00	55.70	63.20
Squaw	SQW055B	86.00	39.80	45.20	58.30	62.60	69.90	40.50	46.00	59.10	62.60	70.20
Squaw	SQW055O	2750.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Squaw	SQW125A	299.00	31.60	36.40	47.10	52.70	63.90	32.20	37.10	47.80	53.90	64.30
Squaw	SQW125O	645.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Squaw	SQW135A	16.00	17.20	18.20	19.70	20.60	22.50	17.30	18.30	19.80	20.80	22.60
Squaw	SQW135B	137.00	28.00	35.60	53.60	62.80	81.30	28.70	36.40	54.40	64.60	81.80
Squaw	SQW135O	2810.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Squaw	SQW145A	238.00	62.40	72.10	92.90	104.00	127.00	63.30	73.00	94.00	106.00	127.00
Squaw	SQW145O	735.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Squaw	SQW205A	1750.00	116.00	136.00	175.00	193.00	235.00	119.00	139.00	179.00	227.00	236.00
Squaw	SQW205O	931.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Squaw	SQW215A	295.00	55.90	65.20	84.20	92.80	123.00	58.50	67.40	86.50	117.00	121.00
Squaw	SQW215O	870.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Squaw	SQW230A	304.00	56.00	65.30	84.40	92.80	135.00	58.60	67.60	86.70	110.00	123.00
Squaw	SQW230O	894.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Squaw	SQW235A	414.00	56.00	65.40	84.30	92.80	125.00	58.60	67.60	86.70	110.00	119.00
Squaw	SQW235O	1220.00	0.00	0.00	0.00	0.00	1.32	0.00	0.00	0.00	0.02	0.09
Squaw	SQW240A	414.00	106.00	123.00	160.00	174.00	199.00	111.00	128.00	164.00	192.00	202.00
Squaw	SQW240O	1220.00	0.00	0.00	0.00	2.32	23.30	0.00	0.00	0.00	13.10	26.80
Squaw	SQW250A	1340.00	53.20	62.00	80.60	88.50	105.00	55.80	64.10	83.30	90.90	106.00
Squaw	SQW250O	2110.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Squaw	SQW260A	305.00	81.00	94.60	122.00	135.00	163.00	81.90	95.50	123.00	138.00	169.00
Squaw	SQW260O	1070.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
Squaw	SQW265A	153.00	12.80	14.90	19.00	21.40	26.30	13.60	16.20	21.30	23.80	29.00
Squaw	SQW265O	1050.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
North	NOR007L	1570.00	191.00	220.00	292.00	326.00	389.00	191.00	220.00	292.00	326.00	389.00
North	NOR010L	43900.00	178.00	212.00	274.00	306.00	363.00	179.00	213.00	275.00	306.00	364.00
North	NOR020L	9260.00	141.00	169.00	219.00	245.00	292.00	142.00	169.00	219.00	245.00	292.00
North	NOR030L	1700.00	114.00	137.00	179.00	199.00	238.00	114.00	137.00	179.00	200.00	238.00
North	NOR035L	1910.00	73.70	88.30	114.00	130.00	154.00	73.70	88.40	114.00	130.00	154.00
North	NOR050L	1650.00	284.00	338.00	427.00	476.00	563.00	286.00	340.00	429.00	478.00	568.00
North	NOR055L	709.00	180.00	212.00	273.00	305.00	358.00	181.00	214.00	274.00	307.00	360.00
North	NOR065L	1000.00	128.00	152.00	195.00	219.00	257.00	129.00	153.00	197.00	220.00	258.00

Table A-5. Model Results - Flows

			Present Flows, cfs					Future Flows, cfs				
Basin	Name	Capacity, cfs	2-year	5-year	10-year	25-year	100-year	2-year	5-year	10-year	25-year	100-year
North	NOR075L	1690.00	75.50	90.00	116.00	131.00	155.00	76.00	90.50	116.00	132.00	156.00
North	NOR080L	2010.00	65.70	78.60	101.00	114.00	135.00	66.10	79.00	101.00	115.00	135.00
North	NOR085L	674.00	71.10	83.00	107.00	118.00	145.00	72.00	83.90	108.00	120.00	147.00
North	NOR090L	468.00	53.40	62.10	79.80	89.80	110.00	53.40	62.20	79.80	90.00	111.00
North	NOR095L	693.00	30.10	35.10	45.10	50.10	60.20	30.10	35.10	45.10	50.10	60.20
North	NOR005A	1180.00	261.00	305.00	395.00	439.00	510.00	263.00	307.00	397.00	442.00	511.00
North	NOR005O	3080.00	0.00	0.00	0.00	0.00	26.70	0.00	0.00	0.00	0.00	28.50
North	NOR015A	582.00	164.00	195.00	252.00	281.00	334.00	164.00	195.00	252.00	282.00	334.00
North	NOR015O	3230.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
North	NOR025A	1390.00	142.00	169.00	219.00	245.00	292.00	142.00	169.00	219.00	245.00	293.00
North	NOR025O	4410.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
North	NOR060A	517.00	180.00	213.00	273.00	305.00	358.00	182.00	214.00	275.00	307.00	360.00
North	NOR060O	3860.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
North	NOR070A	311.00	129.00	152.00	196.00	220.00	257.00	130.00	154.00	197.00	221.00	258.00
North	NOR070O	4140.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Village Green	VLG000L	2420.00	245.00	252.00	269.00	280.00	298.00	245.00	252.00	270.00	281.00	298.00
Village Green	VLG010L	2440.00	237.00	244.00	257.00	266.00	281.00	237.00	244.00	258.00	267.00	281.00
Village Green	VLG020L	757.00	224.00	228.00	236.00	242.00	251.00	224.00	228.00	236.00	242.00	251.00
Village Green	VLG030L	2140.00	218.00	222.00	228.00	232.00	240.00	218.00	222.00	228.00	233.00	240.00
Village Green	VLG040L	752.00	214.00	216.00	221.00	225.00	231.00	214.00	216.00	222.00	225.00	231.00
Village Green	WETLAND	200.00	203.00	203.00	204.00	205.00	207.00	203.00	203.00	204.00	205.00	207.00
Village Green	VLG005A	192.00	237.00	244.00	257.00	266.00	281.00	237.00	244.00	258.00	267.00	281.00
Village Green	VLG005O	3710.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Village Green	VLG015A	282.00	231.00	236.00	246.00	254.00	266.00	231.00	236.00	247.00	255.00	266.00
Village Green	VLG015O	3600.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Village Green	VLG025A	123.00	99.60	101.00	105.00	107.00	112.00	99.60	101.00	105.00	108.00	112.00
Village Green	VLG025B	25.00	24.60	25.20	26.10	26.70	27.80	24.70	25.20	26.20	26.80	27.80
Village Green	VLG025O	2790.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Village Green	VLG035A	75.00	62.90	62.90	62.90	62.30	61.80	62.90	62.90	62.90	62.30	61.80
Village Green	VLG035O	3090.00	43.50	50.20	63.10	71.60	83.00	43.60	50.30	63.90	72.00	83.00
Sequoia	SEQ000L	17000.00	175.00	203.00	260.00	286.00	339.00	178.00	207.00	261.00	289.00	342.00
Sequoia	SEQ020L	1660.00	162.00	189.00	238.00	269.00	305.00	167.00	196.00	247.00	279.00	310.00
Sequoia	SEQ030L	180.00	4.86	5.72	7.31	8.28	9.98	5.82	6.79	9.18	9.67	12.40
Sequoia	SEQ035L	77.00	4.80	5.63	7.28	8.18	9.84	6.56	7.59	9.82	10.70	12.80
Sequoia	SEQ040L	74.00	4.80	5.63	7.28	8.17	9.84	6.61	7.65	9.86	10.80	12.90

Table A-5. Model Results - Flows

			Present Flows, cfs					Future Flows, cfs				
Basin	Name	Capacity, cfs	2-year	5-year	10-year	25-year	100-year	2-year	5-year	10-year	25-year	100-year
Sequoia	SEQ045L	56.00	4.81	5.62	7.27	8.16	9.83	6.66	7.71	9.91	10.80	12.90
Sequoia	SEQ050L	62.00	4.81	5.63	7.27	8.15	9.82	6.70	7.75	9.94	10.90	12.90
Sequoia	SEQ055L	29.00	4.83	5.65	7.28	8.13	9.81	6.81	7.87	10.00	11.10	13.00
Sequoia	SEQ060L	28.00	4.85	5.68	7.33	8.14	9.82	6.90	8.01	10.20	11.30	13.30
Sequoia	SEQ065L	33.00	4.85	5.69	7.35	8.16	9.83	6.92	8.05	10.30	11.40	13.50
Sequoia	SEQ070L	29.00	4.89	5.73	7.38	8.20	9.85	6.97	8.10	10.40	11.50	13.70
Sequoia	SEQ075L	38.00	4.91	5.75	7.42	8.25	9.92	6.99	8.13	10.40	11.50	13.80
Sequoia	SEQ080L	33.00	4.97	5.83	7.53	8.37	10.10	7.04	8.19	10.50	11.70	14.00
Sequoia	SEQ092L	57.00	0.78	1.04	1.40	1.50	2.90	0.79	1.04	1.39	1.42	2.64
Sequoia	SEQ100L	230.00	152.00	181.00	226.00	260.00	288.00	159.00	186.00	234.00	269.00	292.00
Sequoia	SEQ105L	102.00	146.00	173.00	217.00	250.00	282.00	152.00	177.00	225.00	257.00	283.00
Sequoia	SEQ125L	464.00	18.00	22.10	28.70	31.90	38.40	19.70	23.50	30.20	33.50	40.20
Sequoia	SEQ140L	238.00	18.30	22.40	29.00	32.20	38.70	20.10	23.80	30.50	33.80	40.50
Sequoia	SEQ150L	221.00	15.50	18.40	23.80	26.60	32.10	16.90	19.80	25.80	28.90	34.80
Sequoia	SEQ155L	2610.00	123.00	147.00	186.00	218.00	258.00	128.00	149.00	195.00	225.00	265.00
Sequoia	SEQ165L	201.00	113.00	135.00	172.00	199.00	234.00	115.00	137.00	176.00	203.00	238.00
Sequoia	SEQ170L	171.00	85.90	104.00	135.00	152.00	184.00	87.70	106.00	138.00	155.00	187.00
Sequoia	SEQ175L	480.00	80.80	98.10	128.00	143.00	173.00	82.50	100.00	130.00	146.00	177.00
Sequoia	SEQ180L	388.00	81.10	98.60	129.00	144.00	174.00	82.80	100.00	132.00	147.00	177.00
Sequoia	SEQ185L	300.00	81.30	98.90	130.00	145.00	175.00	83.30	101.00	133.00	148.00	178.00
Sequoia	SEQ190L	144.00	31.40	37.30	47.40	51.60	56.40	31.40	37.30	47.30	51.40	55.40
Sequoia	SEQ195L	2.10	25.70	30.50	39.60	41.50	41.10	25.80	30.50	39.70	41.20	39.00
Sequoia	SEQ200L	18.00	21.90	25.80	33.30	34.80	34.20	22.00	25.80	33.40	34.60	34.10
Sequoia	SEQ205L	25.00	9.05	10.60	13.90	15.80	19.20	9.07	10.70	13.90	15.80	19.30
Sequoia	SEQ210L	30.00	0.72	0.94	1.34	1.45	2.65	0.71	0.94	1.34	1.37	2.45
Sequoia	SEQ220L	30.00	0.59	0.61	0.73	0.79	0.94	0.64	0.63	0.75	0.81	0.97
Sequoia	SEQ225L	23.00	0.56	0.61	0.74	0.79	0.94	0.58	0.63	0.75	0.81	0.98
Sequoia	SEQ230L	31.00	-0.56	-0.62	-0.74	-0.79	-0.94	-0.58	-0.63	-0.76	-0.81	-0.98
Sequoia	SEQ231L	6.20	22.30	26.40	34.60	38.60	46.40	23.50	27.70	36.00	40.00	47.90
Sequoia	SEQ235L	103.00	23.00	27.20	35.40	39.40	47.10	24.20	28.40	36.80	40.70	48.70
Sequoia	SEQ240L	116.00	23.10	27.30	35.70	39.80	48.30	24.30	28.60	37.40	41.50	51.00
Sequoia	SEQ245L	30.00	23.10	27.20	35.60	39.60	48.20	24.30	28.50	37.00	41.10	50.30
Sequoia	SEQ250L	60.00	14.80	17.40	22.90	25.50	31.10	15.80	18.60	24.40	26.80	33.30
Sequoia	SEQ255L	52.00	14.80	17.40	22.90	25.50	31.10	15.90	18.60	24.40	26.80	33.40
Sequoia	SEQ260L	52.00	10.70	12.60	16.50	18.30	22.30	11.70	13.70	17.60	19.30	24.10

Table A-5. Model Results - Flows

			Present Flows, cfs					Future Flows, cfs				
Basin	Name	Capacity, cfs	2-year	5-year	10-year	25-year	100-year	2-year	5-year	10-year	25-year	100-year
Sequoia	SEQ265L	35.00	3.62	4.23	5.46	6.08	7.31	3.93	4.59	5.97	6.63	7.98
Sequoia	SEQ270L	30.00	3.63	4.23	5.47	6.08	7.31	3.94	4.60	5.99	6.66	8.01
Sequoia	SEQ275L	28.00	3.63	4.24	5.47	6.09	7.33	3.96	4.61	6.02	6.68	8.04
Sequoia	SEQ280L	28.00	3.64	4.24	5.48	6.09	7.34	3.96	4.62	6.02	6.69	8.05
Sequoia	SEQ285L	21.00	3.63	4.24	5.51	6.13	7.39	3.96	4.61	6.08	6.75	8.12
Sequoia	SEQ290L	881.00	37.00	46.70	62.60	70.00	84.80	37.30	47.20	63.20	70.70	85.60
Sequoia	SEQ305L	88.00	30.10	35.40	46.20	51.30	61.50	31.50	36.80	47.80	52.90	63.40
Sequoia	SEQ310L	455.00	33.80	43.00	57.80	64.70	78.10	34.10	43.40	58.30	65.20	78.70
Sequoia	SEQ320L	598.00	33.80	43.20	58.10	65.00	78.90	34.10	43.50	58.70	65.60	79.60
Sequoia	SEQ330L	593.00	31.80	41.40	54.80	61.20	74.20	32.20	42.00	55.30	61.80	74.80
Sequoia	SEQ340L	879.00	32.50	38.50	50.60	56.50	68.50	32.90	39.00	51.00	57.00	69.10
Sequoia	SEQ360L	150.00	32.70	38.50	50.10	55.60	66.70	34.20	40.00	51.80	57.40	68.70
Sequoia	SEQ365L	84.00	32.80	38.70	50.20	55.70	66.80	34.30	40.10	51.90	57.50	68.70
Sequoia	SEQ370L	68.00	30.00	35.30	46.00	51.10	61.20	31.40	36.70	47.60	52.70	63.10
Sequoia	SEQ375L	76.00	8.40	9.89	12.90	14.50	17.60	8.55	10.10	13.40	14.80	18.10
Sequoia	SEQ380L	71.00	8.44	9.94	12.90	14.40	17.40	8.58	10.10	13.10	14.70	17.80
Sequoia	SEQ385L	71.00	8.45	9.95	12.90	14.40	17.50	8.60	10.10	13.20	14.70	17.80
Sequoia	SEQ390L	91.00	6.47	7.65	9.99	11.20	13.50	6.58	7.76	10.20	11.30	13.80
Sequoia	SEQ005A	347.00	177.00	207.00	262.00	290.00	341.00	181.00	210.00	265.00	294.00	344.00
Sequoia	SEQ005O	4260.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sequoia	SEQ025A	793.00	163.00	191.00	240.00	274.00	308.00	170.00	199.00	250.00	285.00	312.00
Sequoia	SEQ025O	7380.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sequoia	SEQ120A	276.00	60.70	73.80	94.70	110.00	126.00	63.50	75.60	98.50	114.00	126.00
Sequoia	SEQ120B	58.00	29.80	30.00	29.70	30.20	34.80	29.50	29.50	29.80	30.10	35.30
Sequoia	SEQ120O	812.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sequoia	SEQ130A	5.50	11.60	12.40	13.40	13.80	14.50	11.90	12.60	13.60	14.00	14.70
Sequoia	SEQ130O	1410.00	6.47	9.86	15.40	18.20	23.90	7.88	11.00	16.70	19.60	25.60
Sequoia	SEQ145A	3.10	10.60	10.80	10.90	10.90	10.90	10.80	10.90	10.90	10.90	11.00
Sequoia	SEQ145O	1630.00	4.38	7.35	12.70	15.30	21.00	5.82	8.58	14.30	17.10	23.40
Sequoia	SEQ160A	119.00	31.50	37.80	47.90	56.20	66.50	32.60	38.80	50.20	57.90	68.20
Sequoia	SEQ160B	49.00	15.60	17.60	22.50	26.40	31.30	16.00	17.80	23.60	27.20	32.10
Sequoia	SEQ160C	182.00	44.70	53.80	67.80	79.60	94.10	46.40	55.20	71.10	82.00	96.50
Sequoia	SEQ160O	442.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sequoia	SEQ315A	34.00	16.90	21.50	29.00	32.40	39.10	17.10	21.70	29.20	32.70	39.40
Sequoia	SEQ315O	2370.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table A-5. Model Results - Flows

			Present Flows, cfs					Future Flows, cfs				
Basin	**Name**	**Capacity, cfs**	**2-year**	**5-year**	**10-year**	**25-year**	**100-year**	**2-year**	**5-year**	**10-year**	**25-year**	**100-year**
Sequoia	SEQ325A	30.00	33.80	43.20	55.10	57.40	60.80	34.20	43.50	55.30	57.50	60.90
Sequoia	SEQ325O	2830.00	0.00	0.00	3.02	7.72	18.20	0.00	0.00	3.36	8.11	18.70
Sequoia	SEQ335A	19.00	31.80	36.80	40.00	41.40	43.80	32.20	36.90	40.10	41.50	43.90
Sequoia	SEQ335O	2500.00	0.00	4.73	14.80	20.00	30.50	0.00	5.09	15.20	20.40	31.00
Sequoia	SEQ345A	154.00	32.80	38.80	50.90	57.00	69.30	33.20	39.30	51.60	57.70	70.10
Sequoia	SEQ345O	2800.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Garfield	GAR000L	15400.00	29.40	31.50	34.00	45.10	69.00	29.70	31.60	34.10	48.10	70.50
Garfield	GAR010L	1510.00	46.20	54.00	69.30	75.30	88.40	47.50	55.20	70.30	77.00	87.00
Garfield	GAR015L	277.00	27.20	31.60	40.20	44.40	52.20	27.80	32.20	40.80	45.00	52.90
Garfield	GAR025L	971.00	27.80	32.30	41.20	45.50	53.50	28.50	33.20	42.30	46.80	55.50
Garfield	GAR035L	882.00	7.22	8.47	11.00	12.20	14.60	8.24	9.55	12.20	13.50	15.60
Garfield	GAR040L	1280.00	13.10	15.60	20.10	22.60	27.00	14.50	17.00	21.60	24.20	28.40
Garfield	GAR045L	40.00	13.20	15.70	20.90	23.50	28.10	14.50	17.10	22.40	25.10	29.70
Garfield	GAR050L	36.00	13.20	15.70	20.90	23.50	28.20	14.50	17.20	22.50	25.20	29.80
Garfield	GAR055L	66.00	13.20	15.80	21.00	23.60	28.30	14.60	17.20	22.60	25.30	29.80
Garfield	GAR060L	55.00	4.78	5.58	7.52	8.49	10.20	4.78	5.58	7.56	8.50	10.60
Garfield	GAR065L	7.10	4.78	5.58	7.55	8.52	10.20	4.78	5.58	7.51	8.51	10.70
Garfield	GAR070L	7.40	4.81	5.62	7.56	8.52	10.40	4.81	5.62	7.56	8.52	10.40
Garfield	GAR075L	7.70	4.83	5.65	7.56	8.51	10.40	4.83	5.65	7.56	8.51	10.40
Garfield	GAR080L	19.00	2.77	3.21	4.20	4.63	5.48	2.93	3.38	4.39	4.85	5.63
Garfield	GAR085L	3.50	2.67	3.19	4.21	4.66	5.50	2.85	3.39	4.39	4.86	5.62
Garfield	GAR090L	3.20	2.67	3.19	4.20	4.66	5.52	2.85	3.38	4.39	4.87	5.62
Garfield	GAR095L	3.30	1.05	1.25	1.67	1.85	2.30	1.07	1.30	1.68	1.86	2.36
Garfield	GAR100L	43.00	7.47	8.75	11.30	12.50	14.90	8.46	9.80	12.50	13.80	16.30
Garfield	GAR105L	41.00	7.57	8.86	11.40	12.60	15.10	8.56	9.91	12.50	13.90	16.50
Garfield	GAR110L	42.00	6.42	7.52	9.70	10.70	12.90	7.26	8.42	10.70	11.80	14.10
Garfield	GAR120L	37.00	6.50	7.65	9.90	11.00	13.20	7.36	8.56	10.90	12.10	14.40
Garfield	GAR125L	46.00	6.53	7.70	10.00	11.20	13.50	7.40	8.62	11.10	12.30	14.70
Garfield	GAR130L	29.00	6.54	7.71	10.00	11.20	13.60	7.41	8.64	11.10	12.30	14.90
Garfield	GAR135L	9.70	-3.94	-4.60	-5.91	-6.55	-7.92	-3.99	-4.63	-5.93	-6.60	-7.94
Garfield	GAR140L	15.00	3.94	4.59	5.90	6.54	7.91	3.95	4.60	5.91	6.58	7.92
Garfield	GAR145L	11.00	2.81	3.27	4.18	4.62	5.57	2.80	3.26	4.17	4.62	5.55
Garfield	GAR150L	47.00	2.86	3.34	4.32	4.82	5.81	2.85	3.34	4.32	4.81	87.00
Garfield	GAR005A	60.00	29.40	31.50	34.00	36.50	40.90	29.70	31.60	34.10	37.00	41.00
Garfield	GAR005B	3950.00	0.00	0.00	0.00	8.45	28.20	0.00	0.00	0.00	10.50	29.40

Table A-5. Model Results - Flows

			Present Flows, cfs					Future Flows, cfs				
Basin	**Name**	**Capacity, cfs**	**2-year**	**5-year**	**10-year**	**25-year**	**100-year**	**2-year**	**5-year**	**10-year**	**25-year**	**100-year**
Garfield	GAR020A	24.00	27.40	31.80	40.40	44.60	52.40	28.00	32.40	41.00	45.30	53.30
Garfield	GAR020B	4180.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Garfield	GAR030A	25.00	19.90	23.30	29.80	33.10	39.40	21.90	25.50	32.20	35.60	41.80
Garfield	GAR030B	3810.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oak	OAK005L	7360.00	684.00	894.00	1000.00	1030.00	1080.00	691.00	903.00	1010.00	1040.00	1090.00
Oak	OAK015L	7990.00	681.00	890.00	991.00	1020.00	1070.00	688.00	899.00	1000.00	1030.00	1080.00
Oak	OAK025L	14500.00	679.00	887.00	985.00	1010.00	1060.00	686.00	897.00	994.00	1020.00	1070.00
Oak	OAK033L	4350.00	676.00	883.00	976.00	1000.00	1050.00	683.00	892.00	985.00	1010.00	1050.00
Oak	OAK035L	13900.00	663.00	866.00	940.00	960.00	999.00	669.00	874.00	948.00	969.00	1010.00
Oak	OAK045L	3130.00	661.00	864.00	936.00	955.00	993.00	668.00	872.00	944.00	963.00	1000.00
Oak	OAK060L	2310.00	660.00	862.00	931.00	950.00	986.00	666.00	870.00	939.00	958.00	995.00
Oak	OAK080L	2360.00	655.00	856.00	919.00	936.00	968.00	662.00	864.00	926.00	943.00	977.00
Oak	OAK090L	6180.00	656.00	856.00	919.00	936.00	969.00	662.00	865.00	926.00	943.00	977.00
Oak	OAK100L	1180.00	638.00	835.00	882.00	893.00	916.00	643.00	842.00	886.00	897.00	920.00
Oak	OAK103L	8430.00	617.00	810.00	835.00	837.00	841.00	621.00	816.00	835.00	837.00	841.00
Oak	OAK105L	2600.00	617.00	810.00	835.00	837.00	841.00	621.00	816.00	835.00	837.00	841.00
Oak	OAK110L	1930.00	613.00	806.00	826.00	828.00	831.00	617.00	812.00	826.00	829.00	831.00
Oak	OAK120L	4590.00	614.00	807.00	832.00	843.00	850.00	617.00	812.00	832.00	843.00	850.00
Oak	OAK125L	1620.00	554.00	728.00	788.00	812.00	820.00	556.00	730.00	788.00	812.00	820.00
Oak	OAK130L	736.00	537.00	707.00	1080.00	1260.00	1530.00	538.00	709.00	1080.00	1260.00	1530.00
Oak	OAK140L	1820.00	539.00	723.00	1090.00	1260.00	1530.00	540.00	724.00	1090.00	1260.00	1530.00
Oak	OAK150L	5030.00	538.00	721.00	1080.00	1260.00	1600.00	538.00	722.00	1080.00	1260.00	1600.00
Oak	OAK155L	722.00	491.00	660.00	979.00	1130.00	1440.00	491.00	660.00	980.00	1130.00	1440.00
Oak	OAK170L	4910.00	493.00	662.00	985.00	1140.00	1460.00	494.00	663.00	986.00	1140.00	1460.00
Oak	OAK205L	2840.00	450.00	598.00	885.00	1020.00	1310.00	450.00	598.00	885.00	1020.00	1310.00
Oak	OAK215L	1650.00	58.20	72.60	103.00	116.00	146.00	58.20	72.60	103.00	116.00	146.00
Oak	OAK225L	3020.00	20.20	28.20	125.00	-196.00	-243.00	24.10	32.50	123.00	-206.00	256.00
Oak	OAK235L	2050.00	65.40	90.90	137.00	160.00	201.00	69.30	94.50	142.00	164.00	205.00
Oak	OAK245L	1400.00	60.10	83.40	127.00	148.00	185.00	63.90	87.10	131.00	152.00	189.00
Oak	OAK255L	355.00	5.03	6.39	9.03	10.30	13.00	5.66	6.92	9.71	11.20	14.10
Oak	OAK280L	2780.00	48.80	68.00	104.00	120.00	151.00	52.40	71.50	108.00	125.00	156.00
Oak	OAK290L	7580.00	43.90	61.50	92.50	107.00	136.00	48.30	66.20	97.00	112.00	141.00
Oak	OAK295L	127.00	18.50	26.50	36.90	40.50	48.80	19.50	27.10	36.90	40.80	48.80
Oak	OAK305L	71.00	18.70	26.30	36.90	40.50	48.80	19.60	27.10	36.90	40.90	48.80
Oak	OAK310L	71.00	19.00	26.20	36.90	40.70	48.80	19.80	27.20	36.90	40.90	48.80

Table A-5. Model Results - Flows

			Present Flows, cfs					Future Flows, cfs				
Basin	Name	Capacity, cfs	2-year	5-year	10-year	25-year	100-year	2-year	5-year	10-year	25-year	100-year
Oak	OAK315L	71.00	8.46	13.40	19.40	21.90	24.40	9.14	14.20	19.40	21.90	24.40
Oak	OAK325L	71.00	8.46	13.40	19.10	20.90	24.40	9.14	14.20	19.10	20.90	24.40
Oak	OAK330L	43.00	8.51	13.40	19.00	20.50	24.40	9.14	14.20	19.00	20.50	24.30
Oak	OAK335L	43.00	8.48	13.40	19.00	20.40	24.00	9.16	14.20	19.00	20.40	24.00
Oak	OAK340L	43.00	8.48	13.40	19.00	20.40	23.70	9.15	14.20	19.00	20.40	23.70
Oak	OAK345L	43.00	8.50	13.40	19.00	20.40	23.40	9.16	14.20	19.00	20.40	23.40
Oak	OAK350L	569.00	5.16	5.38	6.88	6.85	6.93	5.20	5.40	6.94	6.92	6.80
Oak	OAK355L	5.40	5.14	5.29	6.79	6.88	6.76	5.18	5.44	6.77	6.89	6.76
Oak	OAK365L	5.40	5.14	5.29	6.79	6.88	6.76	5.18	5.48	6.77	6.89	6.76
Oak	OAK370L	5.40	5.15	5.30	6.79	6.88	6.76	5.28	5.50	6.78	6.90	6.76
Oak	OAK375L	19.00	-5.47	-5.77	-9.10	-9.10	-9.10	-5.74	-5.51	-9.10	-9.13	-9.10
Oak	OAK376L	12.00	2.73	5.47	7.22	7.44	6.70	3.55	5.72	7.44	7.49	7.00
Oak	OAK380L	39.00	8.50	13.40	19.00	20.40	22.90	9.15	14.20	19.00	20.40	22.90
Oak	OAK385L	39.00	6.12	9.99	13.70	15.00	16.20	6.92	10.80	14.00	15.00	16.20
Oak	OAK390L	39.00	6.15	10.00	13.80	15.10	16.40	6.92	10.90	14.10	15.10	16.50
Oak	OAK395L	39.00	6.16	10.10	13.90	15.20	16.80	6.93	10.90	14.20	15.20	16.80
Oak	OAK400L	5.80	4.10	7.30	9.47	9.50	9.51	4.56	8.00	9.50	9.50	9.51
Oak	OAK405L	5.70	4.12	7.30	9.47	9.50	9.51	4.58	8.00	9.50	9.50	9.51
Oak	OAK410L	5.70	4.15	7.31	9.47	9.50	9.51	4.71	8.00	9.50	9.50	9.51
Oak	OAK415L	5.70	2.65	4.91	6.66	7.06	6.68	3.38	5.59	7.16	7.17	6.92
Oak	OAK420L	12.00	2.70	5.00	6.66	7.23	6.68	3.51	5.63	7.23	7.30	6.95
Oak	OAK010A	1600.00	342.00	447.00	500.00	513.00	540.00	346.00	452.00	504.00	518.00	544.00
Oak	OAK010B	2060.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oak	OAK020A	7030.00	341.00	445.00	495.00	508.00	534.00	344.00	450.00	500.00	513.00	538.00
Oak	OAK020B	3740.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oak	OAK030A	4980.00	677.00	884.00	978.00	1000.00	1050.00	683.00	893.00	987.00	1010.00	1060.00
Oak	OAK030B	2640.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oak	OAK040A	3990.00	661.00	864.00	936.00	955.00	993.00	668.00	872.00	944.00	963.00	1000.00
Oak	OAK040B	2290.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oak	OAK065A	6850.00	655.00	855.00	919.00	936.00	969.00	661.00	864.00	926.00	943.00	977.00
Oak	OAK065B	1820.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oak	OAK085A	6310.00	655.00	856.00	919.00	936.00	968.00	662.00	864.00	926.00	943.00	977.00
Oak	OAK085B	3660.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oak	OAK115A	287.00	307.00	397.00	402.00	402.00	403.00	308.00	398.00	402.00	402.00	403.00
Oak	OAK115B	1920.00	0.00	12.40	22.60	23.80	25.10	0.00	14.90	22.60	23.90	25.30

Table A-5. Model Results - Flows

			Present Flows, cfs					Future Flows, cfs				
Basin	Name	Capacity, cfs	2-year	5-year	10-year	25-year	100-year	2-year	5-year	10-year	25-year	100-year
Oak	OAK135A	1840.00	537.00	708.00	1080.00	1220.00	1330.00	538.00	709.00	1080.00	1220.00	1330.00
Oak	OAK135B	1920.00	0.00	0.00	0.09	41.40	196.00	0.00	0.00	0.11	41.70	196.00
Oak	OAK145A	1320.00	539.00	724.00	1090.00	1260.00	1590.00	540.00	724.00	1090.00	1260.00	1590.00
Oak	OAK145B	1860.00	0.00	0.00	0.00	0.00	18.40	0.00	0.00	0.00	0.00	18.60
Oak	OAK160A	2360.00	491.00	660.00	980.00	1130.00	1410.00	492.00	661.00	981.00	1130.00	1410.00
Oak	OAK160B	376.00	0.00	0.00	0.00	0.00	35.40	0.00	0.00	0.00	0.00	35.60
Oak	OAK230A	142.00	20.80	28.80	43.30	50.00	63.10	25.00	33.10	47.90	54.80	68.50
Oak	OAK230B	1180.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oak	OAK240A	55.00	3.42	4.57	6.63	7.61	9.74	3.42	4.57	6.63	7.61	9.74
Oak	OAK240B	757.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oak	OAK250A	697.00	3.85	5.27	7.79	8.97	11.30	3.85	5.27	7.79	8.97	11.30
Oak	OAK250B	1080.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oak	OAK260A	108.00	5.27	6.51	9.30	10.80	13.80	5.92	7.25	10.20	11.80	15.00
Oak	OAK260B	260.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oak	OAK285A	190.00	47.20	65.80	100.00	117.00	149.00	50.80	69.50	105.00	121.00	153.00
Oak	OAK285B	226.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Marys River	MRY001A	32.00	6.42	7.47	9.59	10.60	12.70	6.73	7.83	10.20	11.40	14.00
Marys River	MRY001B	2820.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Marys River	MRY003A	27.00	3.60	4.19	5.53	6.21	7.58	3.78	4.50	5.91	6.61	8.05
Marys River	MRY003B	2660.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Marys River	MRY005A	93.00	0.96	1.15	1.55	1.74	2.15	0.98	1.17	1.57	1.77	2.17
Marys River	MRY005B	4230.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Goodnight	GDN005L	64.00	16.70	22.70	33.80	39.10	49.40	24.00	31.20	44.10	49.40	61.40
Goodnight	GDN010L	57.00	16.90	22.80	33.90	39.20	49.50	24.10	31.30	44.20	49.50	61.80
Goodnight	GDN015L	64.00	16.90	22.90	34.00	39.30	49.60	24.20	31.50	44.30	49.60	62.00
Goodnight	GDN030L	65.00	14.70	19.50	28.10	32.20	40.00	20.30	26.10	36.40	40.50	50.70
Goodnight	GDN035L	49.00	13.90	18.50	26.70	30.60	38.20	18.10	22.70	30.70	34.00	39.90
Goodnight	GDN040L	49.00	11.70	15.40	22.20	25.20	31.40	12.40	16.20	22.70	25.10	29.20
Goodnight	GDN045L	9.20	6.45	8.39	11.80	13.20	16.50	6.52	8.44	11.70	13.20	17.50
Goodnight	GDN050L	24.00	1.81	2.30	3.29	4.08	5.25	1.81	2.35	3.41	4.18	10.50
Goodnight	GDN055L	12.00	1.25	1.60	2.15	2.66	3.37	1.25	1.63	2.22	2.74	4.52
Goodnight	GDN060L	41.00	4.27	5.63	8.13	9.36	11.50	4.73	6.06	8.50	9.73	12.90
Goodnight	GDN065L	53.00	4.32	5.68	8.18	9.34	11.60	4.78	6.07	8.48	9.56	13.70
Goodnight	GDN075L	30.00	4.46	5.84	8.37	9.53	11.80	4.92	6.25	8.74	9.81	13.50
Goodnight	GDN085L	35.00	4.55	5.91	8.38	9.40	11.30	4.59	5.94	8.36	9.42	12.50

Table A-5. Model Results - Flows

			Present Flows, cfs					Future Flows, cfs				
Basin	Name	Capacity, cfs	2-year	5-year	10-year	25-year	100-year	2-year	5-year	10-year	25-year	100-year
Goodnight	GDN090L	27.00	4.56	5.92	8.35	9.26	11.30	4.59	5.95	8.17	9.31	12.50
Goodnight	GDN095L	6.30	2.42	3.13	4.42	5.08	6.70	2.44	3.15	4.37	5.47	7.92
Goodnight	GDN100L	33.00	2.38	3.07	4.35	5.03	6.64	2.39	3.09	4.32	5.29	7.46
Goodnight	GDN105L	27.00	1.40	1.79	2.54	2.94	4.20	1.40	1.80	2.48	3.33	5.36
Goodnight	GDN110L	26.00	1.35	1.74	2.50	2.84	3.98	1.36	1.75	2.45	3.10	4.87
Goodnight	GDN115L	6.60	1.33	1.69	2.47	2.79	3.69	1.33	1.69	2.45	2.78	4.17
Goodnight	GDN120L	13.00	1.33	1.68	2.46	2.83	3.38	1.33	1.68	2.46	2.68	3.71
Goodnight	GDN125L	8.30	1.23	1.57	2.27	2.67	3.09	1.23	1.57	2.28	2.59	3.18
Goodnight	GDN130L	9.50	1.24	1.58	2.28	2.70	3.25	1.24	1.58	2.29	2.67	3.18
Goodnight	GDN135L	9.40	1.24	1.59	2.30	2.73	3.42	1.24	1.60	2.31	2.73	3.38
Goodnight	GDN140L	6.30	1.24	1.60	2.32	2.75	3.48	1.25	1.60	2.32	2.75	3.48
Goodnight	GDN145L	1.60	0.15	0.21	0.32	0.37	0.40	0.15	0.21	0.32	0.37	-1.22
Goodnight	GDN150L	1.90	0.13	0.16	0.21	0.23	0.29	0.13	0.16	0.21	0.23	-1.02
Goodnight	GDN155L	1.70	0.15	0.17	0.23	0.25	0.33	0.15	0.17	0.23	0.25	-0.77
Goodnight	GDN160L	2.00	0.14	0.17	0.21	0.24	0.32	0.14	0.17	0.21	0.24	0.66
Goodnight	GDN165L	2.00	0.13	0.16	0.23	0.27	0.31	0.13	0.16	0.23	0.27	0.66
Goodnight	GDN185a	4.50	0.00	0.00	0.03	0.16	0.61	2.86	2.91	2.98	2.99	3.57
Goodnight	GDN185b	948.00	0.00	0.00	0.00	0.00	0.00	1.62	2.74	5.02	6.49	9.25
Goodnight	GDN190L	0.11	-0.25	-0.33	-0.47	-0.51	-0.59	0.85	1.06	1.55	1.81	2.33
Goodnight	GDN500L	12.00	1.19	1.57	2.37	2.88	4.24	4.32	4.80	5.79	6.33	7.60
Goodnight	GDN510L	16.00	1.12	1.48	2.21	2.68	3.97	4.22	4.69	5.62	6.10	7.27
Goodnight	GDN515L	15.00	1.12	1.48	2.21	2.66	3.91	4.23	4.69	5.64	6.03	7.24
Goodnight	GDN520L	17.00	1.12	1.48	2.21	2.67	3.91	4.23	4.69	5.67	6.08	7.22
Goodnight	GDN525L	13.00	0.59	0.82	1.26	1.58	2.42	3.63	3.93	4.52	4.79	5.91
Goodnight	GDN530L	10.00	0.60	0.82	1.23	1.42	1.82	0.81	1.04	1.54	1.82	2.56
Goodnight	GDN535L	6.70	0.60	0.82	1.23	1.42	1.82	0.81	1.04	1.54	1.82	2.49
Goodnight	GDN540L	7.00	0.30	0.42	0.64	0.74	0.95	0.43	0.56	0.80	0.94	1.59
Goodnight	GDN545L	3.10	0.30	0.42	0.64	0.74	0.95	0.44	0.56	0.80	0.95	1.27
Goodnight	GDN550L	4.50	0.31	0.44	0.66	0.76	0.96	0.47	0.59	0.83	0.98	1.27
Goodnight	GDN555L	0.17	-0.96	-1.28	-1.85	-2.01	-2.29	n/a	n/a	n/a	n/a	n/a
Goodnight	GDN560L	0.33	-1.37	-1.38	-1.43	-1.44	-1.34	n/a	n/a	n/a	n/a	n/a
Goodnight	GDN565L	1.50	-1.18	-1.18	-1.18	-1.18	-1.18	n/a	n/a	n/a	n/a	n/a
Goodnight	GDN570L	1.10	1.95	2.04	2.04	2.04	2.04	n/a	n/a	n/a	n/a	n/a
Goodnight	GDN575L	4.30	0.92	0.92	1.01	1.20	1.20	n/a	n/a	n/a	n/a	n/a
Goodnight	GDN580L	1.90	-0.80	0.98	1.23	1.36	1.36	n/a	n/a	n/a	n/a	n/a

Table A-5. Model Results - Flows

			Present Flows, cfs					Future Flows, cfs				
Basin	**Name**	**Capacity, cfs**	**2-year**	**5-year**	**10-year**	**25-year**	**100-year**	**2-year**	**5-year**	**10-year**	**25-year**	**100-year**
Goodnight	GDN585L	1.30	1.11	1.33	1.33	1.33	1.33	n/a	n/a	n/a	n/a	n/a
Mill Race	MIL005L	3830.00	25.90	32.00	50.50	59.00	75.50	29.30	37.60	55.70	64.00	80.80
Mill Race	MIL015L	1280.00	24.70	30.40	48.10	56.10	71.80	27.80	35.80	53.00	60.90	77.30
Mill Race	MIL025L	9570.00	-24.60	-30.30	-47.80	-55.80	-71.40	-27.80	-35.70	-52.80	-60.70	-76.70
Mill Race	MIL040L	9310.00	23.40	28.70	45.20	52.70	67.50	26.40	34.10	50.10	57.70	73.60
Mill Race	MIL050L	955.00	17.00	21.00	33.10	38.50	49.30	17.80	23.30	34.90	40.30	51.40
Mill Race	MIL055L	1060.00	17.00	21.10	33.10	38.60	49.40	17.80	23.20	34.90	40.30	51.30
Mill Race	MIL075L	1960.00	-9.03	-11.20	-17.40	-20.50	-26.60	-9.22	-11.70	-18.20	-21.30	-27.30
Mill Race	MIL085L	1950.00	1.63	2.31	3.54	4.15	5.67	1.69	2.47	3.64	4.37	5.86
Mill Race	MIL090L	1660.00	0.00	0.00	-0.17	-0.30	-0.69	0.00	-0.07	-0.26	-0.45	-0.75
Mill Race	MIL010A	410.00	24.50	30.20	47.70	55.60	71.20	27.60	35.50	52.60	60.40	76.30
Mill Race	MIL010B	165.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mill Race	MIL020A	1150.00	24.50	30.20	47.70	55.70	71.20	27.70	35.50	52.60	60.40	76.50
Mill Race	MIL020B	464.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mill Race	MIL030A	5110.00	25.00	30.70	48.50	56.50	72.50	28.20	36.30	53.60	61.50	78.00
Mill Race	MIL030B	456.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mill Race	MIL045A	1760.00	17.20	21.20	33.20	38.70	49.50	18.10	23.50	35.10	40.50	51.90
Mill Race	MIL045B	409.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mill Race	MIL060A	481.00	11.40	13.90	21.30	24.90	32.10	11.90	14.90	22.60	26.20	33.10
Mill Race	MIL060B	119.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mill Race	MIL080A	37.00	3.50	4.84	7.17	8.54	11.60	3.64	5.07	7.44	9.03	12.00
Mill Race	MIL080B	234.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

TABLE A-6

MODEL RESULTS -- VELOCITIES

Table A-6. Model Results - Velocities

		Design	Present Velocities, fps					Future Velocities, fps				
Basin	Name	Vel, fps	2-year	5-year	10-year	25-year	100-year	2-year	5-year	10-year	25-year	100-year
Dixon	DIX220L	7.22	5.62	5.61	5.64	5.64	5.64	5.62	5.61	5.64	5.64	5.64
Dixon	DIX230L	17.20	3.24	3.23	3.21	3.21	3.47	3.25	3.23	3.22	3.22	3.46
Dixon	DIX240L	10.39	3.57	3.60	3.61	3.61	3.61	3.58	3.60	3.61	3.61	3.61
Dixon	DIX250L	17.23	2.29	2.37	2.41	2.41	2.41	2.30	2.38	2.41	2.41	2.41
Dixon	DIX260L	5.74	5.05	5.06	5.01	5.19	5.26	5.02	5.05	5.00	5.22	5.27
Dixon	DIX265L	4.48	4.58	4.81	4.64	4.68	5.00	4.60	4.81	4.63	4.68	5.04
Dixon	DIX270L	4.80	4.00	4.29	4.29	4.29	4.96	4.01	4.28	4.30	4.29	5.00
Dixon	DIX275L	4.15	4.02	4.33	4.34	4.34	4.34	4.03	4.33	4.35	4.34	4.34
Dixon	DIX280L	4.28	4.10	4.36	4.36	4.36	4.36	4.10	4.36	4.36	4.36	4.36
Dixon	DIX285L	4.21	4.09	4.35	4.35	4.35	4.35	4.10	4.36	4.35	4.35	4.35
Dixon	DIX290L	4.34	4.09	4.35	4.35	4.35	4.35	4.09	4.35	4.35	4.35	4.35
Dixon	DIX295L	3.97	2.74	2.86	4.10	3.55	4.23	2.75	2.86	4.10	3.54	4.23
Dixon	DIX300L	3.22	2.71	2.80	4.09	3.55	4.22	2.71	2.80	4.10	3.56	4.23
Dixon	DIX305L	3.53	2.63	2.70	4.07	3.54	4.21	2.63	2.70	4.07	3.59	4.21
Dixon	DIX310L	4.65	4.61	4.64	4.81	4.71	4.98	4.61	4.64	4.81	4.71	4.98
Dixon	DIX315L	4.92	4.60	4.64	4.79	4.70	4.95	4.60	4.64	4.79	4.70	4.95
Dixon	DIX320L	4.18	4.59	4.63	4.65	4.69	4.68	4.59	4.63	4.65	4.69	4.68
Dixon	DIX325L	4.15	4.57	4.61	4.64	4.68	4.73	4.59	4.61	4.64	4.68	4.73
Dixon	DIX330L	7.80	5.34	5.35	5.35	5.36	5.35	5.34	5.35	5.35	5.35	5.35
Dixon	DIX335L	7.74	6.86	6.86	6.86	6.86	6.86	6.86	6.86	6.86	6.86	6.86
Dixon	DIX340L	7.95	7.29	8.20	8.22	8.22	8.22	7.33	8.20	8.22	8.22	8.22
Dixon	DIX345L	12.17	4.63	4.70	4.82	4.86	4.94	4.74	4.80	4.91	4.97	5.05
Dixon	DIX350L	6.79	3.54	3.67	3.90	3.98	4.14	3.65	3.78	3.99	4.07	4.22
Dixon	DIX355L	12.91	4.30	4.50	4.86	5.02	5.32	4.55	4.75	5.11	5.29	5.58
Dixon	DIX360L	6.68	3.63	4.03	5.39	5.57	5.63	3.60	4.06	5.38	5.57	5.63
Dixon	DIX365L	7.28	5.06	5.08	5.11	5.26	5.83	5.06	5.08	5.11	5.26	5.83
Dixon	DIX370L	10.31	7.35	7.36	7.35	7.32	7.39	7.35	7.35	7.36	7.32	7.38
Dixon	DIX375L	10.91	8.08	8.26	8.36	8.37	8.30	8.08	8.25	8.35	8.36	8.29
Dixon	DIX380L	17.02	8.86	9.18	10.70	11.04	11.10	8.85	9.17	10.72	11.04	11.09
Dixon	DIX385L	18.29	10.42	10.69	11.21	11.41	11.64	10.42	10.69	11.21	11.41	11.64
Dixon	DIX390L	20.41	6.45	6.60	6.89	7.01	7.12	6.45	6.60	6.89	7.02	7.11
Dixon	DIX395L	4.76	6.44	7.48	8.76	8.57	9.59	6.37	7.53	8.72	8.53	9.66
Dixon	DIX400L	8.19	3.94	3.89	4.64	4.85	5.07	3.93	3.91	4.66	4.93	5.09
Dixon	DIX405L	8.16	5.92	5.86	5.85	5.93	5.99	5.91	5.87	5.85	5.92	5.99
Dixon	DIX410L	11.79	8.26	8.47	8.43	8.45	8.41	8.27	8.48	8.44	8.47	8.41

Table A-6. Model Results - Velocities

		Design	Present Velocities, fps					Future Velocities, fps				
Basin	Name	Vel, fps	2-year	5-year	10-year	25-year	100-year	2-year	5-year	10-year	25-year	100-year
Dixon	DIX415L	11.97	7.77	8.00	8.30	8.50	8.74	7.79	8.02	8.30	8.52	8.75
Dixon	DIX420L	3.85	3.31	3.36	3.64	3.48	3.38	3.46	3.56	3.62	3.46	3.53
Dixon	DIX425L	5.58	2.70	2.98	3.56	3.50	3.53	2.91	3.24	3.53	3.54	3.54
Dixon	DIX430L	5.18	3.32	3.35	3.57	3.52	3.64	3.39	3.46	3.57	3.56	3.66
Dixon	DIX435L	4.47	4.11	4.16	4.60	4.53	4.41	4.20	4.26	4.63	4.56	4.45
Dixon	DIX440L	9.08	3.50	3.93	4.95	5.37	6.18	3.88	4.57	5.52	5.97	6.66
Dixon	DIX445L	8.89	5.63	5.81	6.13	6.24	6.47	5.80	6.01	6.29	6.41	6.62
Dixon	DIX450L	9.03	5.74	5.86	6.05	6.06	6.09	5.84	5.99	6.08	6.08	6.12
Dixon	DIX455L	12.33	7.73	7.94	8.27	8.37	8.52	7.92	8.14	8.41	8.50	8.59
Dixon	DIX460L	12.38	7.50	7.73	8.06	8.21	8.47	7.70	7.93	8.26	8.41	8.64
Dixon	DIX465L	15.32	8.63	8.95	9.35	9.53	9.83	8.97	9.17	9.59	9.78	10.05
Dixon	DIX480L	11.33	3.71	3.71	3.73	3.72	3.72	3.71	3.71	3.73	3.73	3.73
Dixon	DIX490L	11.04	6.83	6.96	7.06	7.05	7.10	6.84	6.95	7.05	7.06	7.09
Dixon	DIX500L	8.06	6.71	6.92	7.19	7.27	7.41	6.74	6.94	7.21	7.29	7.41
Dixon	DIX510L	6.71	4.96	5.07	5.19	5.22	5.27	4.98	5.08	5.20	5.22	5.27
Dixon	DIX520L	6.70	3.42	3.50	3.57	3.57	3.57	3.43	3.51	3.57	3.57	3.57
Dixon	DIX530L	6.34	3.21	3.33	3.46	3.46	3.44	3.23	3.34	3.46	3.46	3.44
Dixon	DIX540L	5.36	5.65	5.81	6.10	6.08	6.05	5.68	5.84	6.12	6.03	6.11
Dixon	DIX555L	3.68	4.44	4.58	4.76	4.78	4.83	4.47	4.60	4.77	4.80	4.83
Dixon	DIX565L	4.53	5.06	5.15	5.13	5.06	5.07	5.08	5.12	5.07	5.07	5.13
Dixon	DIX570L	4.80	5.00	5.35	5.77	5.81	5.85	5.06	5.39	5.79	5.83	5.88
Dixon	DIX580L	12.46	6.05	6.31	6.36	6.39	6.50	6.11	6.34	6.55	6.36	6.34
Dixon	DIX585L	3.48	4.38	4.93	5.53	5.83	6.36	4.47	5.02	5.57	5.91	6.40
Dixon	DIX595L	15.35	8.20	8.21	8.21	8.21	8.20	8.21	8.22	8.22	8.23	8.21
Dixon	DIX605L	11.18	4.21	4.33	4.67	4.77	4.93	4.22	4.36	4.68	4.79	4.94
Dixon	DIX613L	2.14	5.78	6.07	6.74	7.41	8.54	5.84	6.12	6.81	7.58	8.61
Dixon	DIX615L	13.12	4.83	5.02	5.28	5.26	5.25	4.87	5.05	5.26	5.26	5.25
Dixon	DIX625L	6.58	6.10	6.33	6.68	6.83	6.96	6.14	6.37	6.70	6.86	7.01
Dixon	DIX630L	18.63	4.22	4.33	4.40	4.36	4.35	4.25	4.33	4.40	4.35	4.37
Dixon	DIX640L	8.76	4.62	4.74	5.04	5.28	5.58	4.62	4.73	5.09	5.30	5.46
Dixon	DIX650L	5.47	4.38	4.56	4.85	4.95	5.14	4.40	4.58	4.86	4.96	5.14
Dixon	DIX660L	21.66	3.29	3.34	3.68	3.67	3.57	3.28	3.32	3.60	3.60	3.52
Dixon	DIX665L	21.56	6.76	6.83	6.99	7.08	7.22	6.77	6.83	7.00	7.10	7.22
Dixon	DIX670L	5.20	2.47	2.59	2.91	3.09	3.50	2.52	2.64	2.96	3.02	3.57
Dixon	DIX680L	11.44	2.21	2.33	2.41	2.42	2.38	2.57	2.69	2.68	2.71	2.59

Table A-6. Model Results - Velocities

		Design	Present Velocities, fps					Future Velocities, fps				
Basin	Name	Vel, fps	2-year	5-year	10-year	25-year	100-year	2-year	5-year	10-year	25-year	100-year
Dixon	DIX690L	3.63	1.40	1.46	1.55	1.58	1.64	1.46	1.52	1.61	1.65	1.71
Dixon	DIX695L	15.25	2.60	2.65	2.58	2.64	2.55	2.59	2.62	2.62	2.62	2.64
Dixon	DIX698L	2.02	3.52	3.72	4.03	4.29	4.49	3.56	3.75	4.08	4.32	4.42
Dixon	DIX700L	10.76	3.42	3.62	4.18	4.53	5.22	3.46	3.66	4.26	4.62	5.31
Dixon	DIX710L	13.61	5.69	6.00	6.54	6.76	7.16	5.78	6.09	6.62	6.83	7.24
Dixon	DIX715L	16.71	5.70	5.94	6.34	6.52	6.84	5.78	6.01	6.40	6.59	6.90
Dixon	DIX720L	13.96	5.58	5.89	6.41	6.64	7.04	5.68	5.98	6.50	6.72	7.12
Dixon	DIX725L	10.63	4.36	4.60	5.01	5.19	5.50	4.45	4.69	5.08	5.26	5.57
Dixon	DIX735L	14.26	6.33	6.66	7.23	7.47	7.92	6.38	6.71	7.28	7.52	7.97
Dixon	DIX740L	15.85	5.56	5.79	6.19	6.36	6.67	5.62	5.85	6.23	6.41	6.72
Dixon	DIX745L	19.47	6.94	7.32	7.96	8.24	8.74	7.01	7.39	8.02	8.30	8.80
Dixon	DIX750L	10.04	4.23	4.45	4.84	5.01	5.31	4.28	4.50	4.88	5.05	5.35
Dixon	DIX760L	13.72	5.78	6.09	6.62	6.85	7.26	5.84	6.15	6.67	6.90	7.31
Dixon	DIX775L	14.98	1.47	1.54	1.66	1.72	1.82	1.48	1.55	1.68	1.73	1.84
Dixon	DIX785L	32.04	1.83	1.87	1.92	1.94	1.98	1.86	1.90	1.95	1.98	2.00
Dixon	DIX790L	16.11	3.21	3.45	3.85	4.05	4.39	3.34	3.57	3.98	4.16	4.52
Dixon	DIX795L	16.93	3.88	4.10	4.46	4.64	4.94	4.08	4.30	4.68	4.89	5.21
Dixon	DIX805L	5.63	5.53	5.77	6.07	6.56	6.96	5.55	5.79	6.09	6.56	6.98
Dixon	DIX810L	10.43	5.19	5.47	5.67	7.02	7.42	5.20	5.49	5.70	7.00	7.45
Dixon	DIX815L	6.74	5.51	5.79	5.91	6.64	6.66	5.52	5.79	5.91	6.65	6.66
Dixon	DIX820L	8.01	5.31	5.57	5.68	7.27	7.39	5.33	5.59	5.67	7.35	7.54
Dixon	DIX825L	8.37	6.23	6.51	6.68	8.16	8.25	6.24	6.54	6.68	8.22	8.40
Dixon	DIX835L	9.05	3.79	4.33	5.04	5.97	5.99	3.81	4.37	4.99	5.99	6.07
Dixon	DIX845L	29.23	4.81	4.91	4.93	4.94	4.94	4.82	4.91	4.93	4.94	4.94
Dixon	DIX855L	30.50	2.58	2.64	2.66	2.59	2.64	2.59	2.61	2.64	2.56	2.64
Dixon	DIX865L	27.97	10.17	10.47	10.03	10.16	9.71	10.15	10.01	10.00	10.18	9.64
Dixon	DIX874L	14.85	3.80	4.35	5.38	5.84	6.73	3.82	4.37	5.40	5.87	6.76
Dixon	DIX875L	18.22	0.90	0.90	1.48	1.31	0.90	1.85	0.90	0.90	0.92	1.04
Dixon	DIX885L	12.44	7.87	8.25	8.88	9.14	9.61	7.89	8.26	8.89	9.16	9.63
Dixon	DIX890L	12.28	7.16	7.50	8.07	8.31	8.74	7.17	7.51	8.08	8.32	8.75
Dixon	DIX895L	21.31	1.13	1.12	1.07	1.13	1.15	1.15	1.30	1.10	1.12	1.18
Dixon	DIX905L	16.31	1.13	1.13	1.13	1.16	1.22	1.13	1.13	1.15	1.18	1.23
Dixon	DIX915L	28.28	8.34	8.68	9.22	9.44	9.84	8.34	8.68	9.22	9.44	9.85
Dixon	DIX925L	12.45	3.16	3.61	4.46	4.84	5.58	3.17	3.62	4.48	4.86	5.60
Dixon	DIX930L	15.19	6.43	6.76	7.30	7.55	8.00	6.41	6.74	7.29	7.54	7.98

Table A-6. Model Results - Velocities

		Design	Present Velocities, fps					Future Velocities, fps				
Basin	Name	Vel, fps	2-year	5-year	10-year	25-year	100-year	2-year	5-year	10-year	25-year	100-year
Dixon	DIX935L	14.55	2.32	2.45	2.68	2.80	3.02	2.48	2.61	2.84	2.95	3.15
Dixon	DIX945L	15.37	2.74	2.86	3.05	3.08	3.24	2.77	2.88	3.08	3.12	3.23
Dixon	DIX950L	15.77	4.13	4.35	4.72	4.84	5.13	4.13	4.36	4.72	4.84	5.14
Dixon	DIX955L	7.01	3.01	3.18	3.47	3.55	3.78	3.01	3.18	3.46	3.55	3.78
Dixon	DIX960L	19.95	2.83	3.00	3.30	3.40	3.62	2.83	3.00	3.30	3.40	3.63
Dixon	DIX970L	21.23	1.43	1.45	1.48	1.47	1.49	1.43	1.45	1.48	1.47	1.49
Dixon	DIX995L	17.28	1.28	1.33	1.36	1.36	1.39	1.28	1.33	1.36	1.36	1.38
Dixon	DIXOUTL	13.18	8.69	9.08	9.59	9.77	10.14	8.75	9.12	9.61	9.81	10.14
Dixon	DIX225A	14.61	3.06	3.15	3.23	3.24	3.25	3.08	3.16	3.25	3.23	3.25
Dixon	DIX225O	75.91	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX235A	13.75	5.85	6.16	6.33	6.34	6.40	5.90	6.20	6.33	6.34	6.39
Dixon	DIX235O	90.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX245A	15.49	5.75	5.99	6.27	6.31	6.44	5.79	6.02	6.29	6.33	6.44
Dixon	DIX245O	114.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX255A	11.27	3.21	3.35	3.56	3.61	3.73	3.23	3.37	3.57	3.63	3.73
Dixon	DIX255O	76.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX475A	15.11	8.81	9.28	9.97	10.20	10.67	8.88	9.34	10.00	10.24	10.67
Dixon	DIX475O	107.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX485A	17.54	4.99	5.04	5.10	5.10	5.21	5.00	5.04	5.10	5.09	5.23
Dixon	DIX485O	99.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX495A	29.66	5.58	5.98	6.56	6.73	7.07	5.64	6.03	6.59	6.78	7.07
Dixon	DIX495O	188.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX505A	10.24	5.75	6.00	6.38	6.49	6.72	5.79	6.03	6.40	6.52	6.72
Dixon	DIX505O	65.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX515A	12.45	3.95	4.21	4.62	4.82	5.66	3.99	4.24	4.65	4.89	5.69
Dixon	DIX515O	95.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX525A	0.00	2.87	3.10	3.44	3.57	4.25	2.91	3.13	3.46	3.62	4.28
Dixon	DIX525O	90.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX535A	14.17	3.66	3.84	4.08	4.12	4.24	3.70	3.86	4.09	4.13	4.25
Dixon	DIX535O	83.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX545A	19.99	5.37	5.73	6.23	6.35	6.52	5.44	5.78	6.27	6.38	6.53
Dixon	DIX545O	95.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX560A	12.76	5.07	5.32	5.70	5.87	6.93	5.11	5.36	5.73	5.96	6.96
Dixon	DIX560B	8.24	5.08	5.38	5.98	6.03	6.35	5.13	5.43	5.99	6.08	6.38
Dixon	DIX560O	92.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table A-6. Model Results - Velocities

		Design	Present Velocities, fps					Future Velocities, fps				
Basin	Name	Vel, fps	2-year	5-year	10-year	25-year	100-year	2-year	5-year	10-year	25-year	100-year
Dixon	DIX575A	13.73	5.12	5.38	5.78	5.91	6.24	5.17	5.41	5.81	5.94	6.26
Dixon	DIX575B	8.43	4.83	5.06	5.46	5.59	6.08	4.87	5.09	5.48	5.63	6.10
Dixon	DIX575O	59.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX590A	14.68	4.67	5.09	5.59	5.83	6.24	4.74	5.15	5.62	5.89	6.27
Dixon	DIX590O	71.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX600A	6.91	4.70	4.82	5.32	5.68	6.61	4.70	4.87	5.35	5.79	6.71
Dixon	DIX600O	55.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX610A	16.58	5.31	5.55	5.94	5.97	6.06	5.35	5.59	5.95	6.00	6.07
Dixon	DIX610O	77.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX620A	20.39	5.84	6.16	6.55	6.56	6.54	5.90	6.21	6.55	6.57	6.55
Dixon	DIX620O	125.73	0.00	0.00	0.00	0.00	2.28	0.00	0.00	0.00	0.00	2.56
Dixon	DIX635A	14.99	5.41	5.70	6.16	6.49	7.21	5.47	5.75	6.19	6.55	7.32
Dixon	DIX635O	79.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX645A	12.60	3.01	3.14	3.36	3.44	3.59	3.02	3.15	3.37	3.44	3.59
Dixon	DIX645O	66.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX655A	17.75	5.76	5.99	6.45	6.67	7.13	5.78	6.01	6.48	6.69	7.18
Dixon	DIX655O	80.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX675A	12.91	3.27	3.45	3.92	4.44	5.44	3.33	3.50	3.99	4.66	5.56
Dixon	DIX675O	67.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX685A	9.95	4.29	4.46	4.74	4.87	5.11	4.45	4.62	4.92	5.02	5.27
Dixon	DIX685O	55.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX705A	15.76	6.56	6.79	7.27	7.49	8.03	6.61	6.84	7.32	7.56	8.12
Dixon	DIX705O	28.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX730A	4.84	5.12	5.26	5.47	5.56	5.73	5.17	5.29	5.50	5.58	5.75
Dixon	DIX730O	33.36	5.05	5.38	5.74	5.86	6.08	5.16	5.43	5.77	5.90	6.12
Dixon	DIX755A	8.76	6.08	6.29	6.75	7.00	7.38	6.13	6.34	6.82	7.07	7.43
Dixon	DIX755O	47.58	0.00	0.00	3.66	5.01	6.42	0.00	0.00	4.05	5.28	6.56
Dixon	DIX780A	4.84	3.48	3.62	3.86	3.94	4.15	3.50	3.64	3.88	3.94	4.18
Dixon	DIX780O	33.36	0.00	0.00	0.00	1.57	3.00	0.00	0.00	0.00	1.74	3.10
Dixon	DIX800A	11.32	6.90	7.06	7.27	7.29	7.65	7.00	7.14	7.32	7.43	7.80
Dixon	DIX800O	44.91	0.00	0.00	2.35	3.77	5.39	0.00	0.00	3.50	4.58	6.01
Dixon	DIX830A	8.76	8.58	8.80	12.69	13.17	12.94	8.59	8.81	12.87	13.24	13.44
Dixon	DIX830O	21.90	5.36	5.76	7.17	8.29	8.42	5.38	5.78	7.78	8.40	8.68
Dixon	DIX840A	14.58	5.09	5.40	5.64	6.65	6.47	5.10	5.42	5.60	6.60	6.60
Dixon	DIX840O	58.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27

Table A-6. Model Results - Velocities

		Design	Present Velocities, fps					Future Velocities, fps				
Basin	Name	Vel, fps	2-year	5-year	10-year	25-year	100-year	2-year	5-year	10-year	25-year	100-year
Dixon	DIX850A	11.00	9.13	10.04	10.79	11.13	11.71	9.19	10.07	10.81	11.15	11.73
Dixon	DIX850O	56.23	0.00	7.04	7.58	7.79	8.01	0.00	7.12	7.60	7.80	8.01
Dixon	DIX860A	13.02	10.00	10.32	10.78	10.78	10.77	10.03	10.34	10.78	10.78	10.77
Dixon	DIX860O	55.68	0.00	0.00	0.00	8.07	11.42	0.00	0.00	3.12	8.44	11.48
Dixon	DIX870A	8.27	10.46	12.03	14.88	16.21	18.91	10.51	12.08	14.92	16.29	18.94
Dixon	DIX870O	117.94	0.00	0.00	0.00	0.00	0.39	0.00	0.00	0.00	0.00	0.64
Dixon	DIX880A	10.97	2.89	2.99	3.15	3.22	3.34	2.97	3.06	3.23	3.29	3.42
Dixon	DIX880O	61.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX900A	15.71	4.18	4.30	4.56	4.67	4.90	4.21	4.34	4.59	4.71	4.95
Dixon	DIX900O	89.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX910A	7.06	3.14	3.27	3.49	3.60	3.79	3.17	3.29	3.52	3.62	3.82
Dixon	DIX910O	23.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX920A	9.30	8.81	9.17	9.76	10.00	10.43	8.82	9.18	9.77	10.01	10.44
Dixon	DIX920O	30.45	5.56	5.83	6.30	6.50	6.88	5.57	5.83	6.31	6.51	6.89
Dixon	DIX940A	13.39	7.09	7.33	7.73	7.89	8.16	7.17	7.41	7.80	7.95	8.22
Dixon	DIX940O	48.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX965A	8.37	4.13	4.38	5.04	5.63	6.59	4.13	4.38	5.03	5.62	6.59
Dixon	DIX965O	61.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixon	DIX975A	10.39	4.14	4.40	5.10	5.71	6.70	4.14	4.40	5.09	5.71	6.70
Dixon	DIX975O	76.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Squaw	SQW005L	1.73	1.66	1.66	1.67	1.67	1.68	1.66	1.66	1.67	1.68	1.68
Squaw	SQW006L	1.43	1.08	1.09	1.09	1.08	1.08	1.08	1.10	1.08	1.08	1.08
Squaw	SQW007L	1.40	1.03	1.03	1.03	1.03	1.04	1.03	1.03	1.03	1.03	1.04
Squaw	SQW008L	0.70	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28
Squaw	SQW010L	1.15	1.22	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.22
Squaw	SQW015L	0.95	1.00	0.99	0.97	0.98	0.99	1.00	0.99	0.99	0.98	0.99
Squaw	SQW021L	2.43	1.39	1.41	1.42	1.42	1.42	1.39	1.41	1.42	1.41	1.42
Squaw	SQW022L	1.39	1.70	1.71	1.66	1.68	1.68	1.70	1.70	1.68	1.68	1.69
Squaw	SQW023L	1.44	2.09	2.09	2.14	2.14	2.11	2.09	2.11	2.14	2.13	2.11
Squaw	SQW024L	2.56	2.48	2.50	2.48	2.49	2.49	2.49	2.51	2.49	2.50	2.50
Squaw	SQW025L	9.68	3.00	3.43	4.00	4.22	4.51	3.04	3.49	4.04	4.35	4.52
Squaw	SQW035L	2.39	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25
Squaw	SQW040L	1.55	1.44	1.44	1.61	1.61	1.51	1.45	1.45	1.63	1.62	1.52
Squaw	SQW050L	4.68	0.29	0.29	0.31	0.31	0.35	0.30	0.31	0.33	0.34	0.37
Squaw	SQW060L	2.08	2.00	1.99	1.99	1.99	2.00	2.00	1.99	1.99	2.00	1.99

Table A-6. Model Results - Velocities

		Design	Present Velocities, fps					Future Velocities, fps				
Basin	Name	Vel, fps	2-year	5-year	10-year	25-year	100-year	2-year	5-year	10-year	25-year	100-year
Squaw	SQW075L	5.41	1.16	1.25	1.53	1.68	1.95	1.18	1.30	1.57	1.73	2.04
Squaw	SQW080L	4.65	1.82	1.93	2.13	2.22	2.37	1.93	2.04	2.23	2.32	2.48
Squaw	SQW085L	3.44	2.56	2.69	3.09	3.33	3.55	2.59	2.71	3.11	3.27	3.57
Squaw	SQW090L	6.20	2.34	2.37	2.46	2.54	2.67	2.53	2.52	2.58	2.63	2.79
Squaw	SQW095L	4.33	2.78	2.87	2.93	2.96	2.85	2.81	2.87	2.91	2.81	2.87
Squaw	SQW100L	4.73	2.97	2.95	3.06	3.07	3.11	2.96	3.03	3.09	3.10	3.08
Squaw	SQW105L	4.48	3.29	3.23	3.21	3.25	3.30	3.26	3.18	3.24	3.27	3.33
Squaw	SQW110L	5.10	4.30	4.28	4.79	4.77	4.77	4.31	4.59	4.77	4.77	4.77
Squaw	SQW120L	4.37	5.18	5.93	6.88	6.86	6.79	5.60	6.52	6.87	6.84	6.81
Squaw	SQW130L	6.41	3.23	3.33	3.52	3.61	3.74	3.26	3.36	3.55	3.64	3.76
Squaw	SQW140L	14.73	3.23	3.31	3.39	3.58	4.21	3.24	3.32	3.39	3.67	4.23
Squaw	SQW150L	1.62	1.88	1.87	1.89	1.91	1.91	1.84	1.82	1.84	1.84	1.85
Squaw	SQW155L	7.12	2.35	2.44	2.70	2.87	3.22	2.32	2.40	2.70	2.88	3.23
Squaw	SQW160L	5.95	2.50	2.63	2.83	2.92	3.11	2.51	2.64	2.85	2.95	3.14
Squaw	SQW165L	9.80	2.27	2.33	2.47	2.45	2.44	2.31	2.37	2.53	2.51	2.50
Squaw	SQW170L	5.12	0.59	0.62	1.76	2.40	4.42	0.92	1.04	1.83	2.58	4.47
Squaw	SQW175L	4.99	1.56	1.55	1.56	1.68	2.33	1.87	1.87	1.84	1.94	2.28
Squaw	SQW180L	6.31	3.07	3.25	3.46	3.44	3.50	3.30	3.43	3.56	3.56	3.41
Squaw	SQW185L	5.60	3.53	3.59	3.40	3.47	3.59	3.70	3.51	3.50	3.57	3.69
Squaw	SQW190L	6.97	4.29	4.62	4.91	5.00	5.18	4.47	4.88	5.11	5.21	5.29
Squaw	SQW195L	7.03	5.08	5.27	5.57	5.69	5.89	5.34	5.53	5.80	5.91	6.11
Squaw	SQW200L	2.86	1.72	1.73	1.71	1.68	1.64	1.75	1.74	1.69	1.69	1.60
Squaw	SQW210L	1.33	0.58	0.68	0.88	0.97	1.18	0.60	0.70	0.90	1.17	1.18
Squaw	SQW220L	0.00	3.69	3.92	4.24	4.37	4.99	3.78	4.05	4.34	4.73	4.94
Squaw	SQW245L	5.40	3.92	3.93	3.97	3.98	4.20	3.94	3.98	4.00	4.11	4.24
Squaw	SQW255L	4.90	2.22	2.26	2.49	2.60	2.78	2.29	2.31	2.56	2.65	2.82
Squaw	SQW270L	7.48	3.32	3.34	3.35	3.36	3.36	3.35	3.37	3.36	3.36	3.35
Squaw	SQWOUTL	48.96	10.18	10.13	10.17	10.18	10.35	10.21	10.15	10.17	10.29	10.31
Squaw	SQW000A	28.86	2.71	2.64	2.71	2.66	2.84	2.74	2.64	2.65	2.76	2.78
Squaw	SQW020A	4.06	2.92	2.96	2.98	3.01	3.01	2.93	2.96	2.99	3.01	3.01
Squaw	SQW020O	13.52	3.06	3.09	3.11	3.12	3.12	3.07	3.09	3.11	3.12	3.13
Squaw	SQW045A	8.91	1.65	1.93	2.67	2.87	3.24	1.69	1.99	2.71	2.87	3.27
Squaw	SQW045O	12.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Squaw	SQW055A	6.97	6.18	6.48	7.46	8.19	9.08	6.21	6.53	7.55	8.13	9.11
Squaw	SQW055B	7.32	6.15	6.43	7.30	8.00	8.89	6.18	6.47	7.37	7.92	8.93

Table A-6. Model Results - Velocities

		Design	Present Velocities, fps					Future Velocities, fps				
Basin	Name	Vel, fps	2-year	5-year	10-year	25-year	100-year	2-year	5-year	10-year	25-year	100-year
Squaw	SQW055O	54.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Squaw	SQW125A	10.59	2.04	2.13	2.34	2.45	2.66	2.07	2.17	2.38	2.49	2.69
Squaw	SQW125O	12.83	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Squaw	SQW135A	5.22	5.40	5.66	6.24	6.51	7.12	5.42	5.69	6.26	6.57	7.14
Squaw	SQW135B	9.38	5.04	5.34	6.00	6.35	7.18	5.07	5.37	6.03	6.42	7.20
Squaw	SQW135O	56.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Squaw	SQW145A	10.43	6.15	6.42	6.99	7.32	8.13	6.18	6.45	7.02	7.39	8.14
Squaw	SQW145O	14.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Squaw	SQW205A	19.39	2.27	2.57	3.15	3.39	3.92	2.33	2.62	3.20	3.84	3.94
Squaw	SQW205O	18.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Squaw	SQW215A	12.31	3.16	3.41	3.85	4.05	4.82	3.24	3.55	3.99	4.65	4.87
Squaw	SQW215O	17.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Squaw	SQW230A	12.66	2.62	2.82	3.23	3.56	5.62	2.68	2.87	3.30	4.51	5.10
Squaw	SQW230O	17.79	0.00	0.00	0.00	0.00	0.78	0.00	0.00	0.00	0.00	0.27
Squaw	SQW235A	17.25	2.84	2.98	3.24	3.68	5.11	2.88	3.02	3.30	4.58	4.97
Squaw	SQW235O	24.25	0.00	0.00	0.00	0.00	2.84	0.00	0.00	0.00	1.48	2.01
Squaw	SQW240A	17.25	5.21	5.37	6.40	7.14	8.19	5.27	5.42	6.56	7.68	8.40
Squaw	SQW240O	24.25	0.00	0.00	0.00	2.78	5.19	0.00	0.00	0.00	4.58	5.88
Squaw	SQW250A	33.48	2.66	2.67	2.85	2.87	2.94	2.66	2.69	2.89	2.93	2.99
Squaw	SQW250O	41.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Squaw	SQW260A	15.52	5.95	6.29	7.14	7.63	9.04	5.98	6.33	7.18	7.75	9.32
Squaw	SQW260O	21.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.31
Squaw	SQW265A	12.18	4.37	4.46	4.63	4.71	4.87	4.45	4.56	4.75	4.83	4.99
Squaw	SQW265O	20.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
North	NOR007L	6.83	5.06	5.14	5.24	5.23	5.23	5.05	5.15	5.22	5.24	5.23
North	NOR010L	15.45	0.68	0.70	0.79	0.79	0.83	0.68	0.70	0.81	0.79	0.83
North	NOR020L	15.42	2.37	2.44	2.46	2.43	2.43	2.37	2.44	2.45	2.43	2.42
North	NOR030L	11.04	4.38	5.65	6.17	4.40	4.61	4.39	5.65	6.17	4.40	4.61
North	NOR035L	17.50	9.03	9.13	9.79	10.77	11.32	9.03	9.12	9.79	10.77	11.32
North	NOR050L	7.20	5.50	5.58	5.91	6.19	6.26	5.50	5.62	5.95	6.24	6.25
North	NOR055L	5.20	3.30	3.65	4.23	4.48	4.83	3.32	3.67	4.25	4.49	4.85
North	NOR065L	7.36	3.64	3.68	3.85	3.93	4.04	3.66	3.69	3.85	3.93	4.05
North	NOR075L	11.76	2.63	2.72	2.80	2.83	2.77	2.62	2.67	2.76	2.77	2.71
North	NOR080L	13.96	6.58	6.99	7.58	7.90	8.31	6.60	7.01	7.60	7.92	8.32
North	NOR085L	11.33	2.96	3.22	3.82	4.03	4.60	2.98	3.24	3.84	4.09	4.63

Table A-6. Model Results - Velocities

Basin	Name	Design Vel, fps	Present Velocities, fps					Future Velocities, fps				
			2-year	5-year	10-year	25-year	100-year	2-year	5-year	10-year	25-year	100-year
North	NOR090L	12.47	5.79	6.11	6.63	6.85	7.23	5.74	6.00	6.53	6.75	7.13
North	NOR095L	18.47	5.34	5.61	6.06	6.26	6.61	5.33	5.60	6.06	6.26	6.61
North	NOR005A	16.79	5.59	5.89	7.22	8.14	9.17	5.61	5.91	7.29	8.17	9.18
North	NOR005B	61.27	0.00	0.00	0.00	0.00	3.60	0.00	0.00	0.00	0.00	3.81
North	NOR015A	8.66	7.02	7.35	7.89	8.17	8.68	7.02	7.35	7.90	8.18	8.68
North	NOR015B	64.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
North	NOR025A	12.29	3.37	3.66	4.17	4.41	4.80	3.37	3.66	4.17	4.41	4.80
North	NOR025B	87.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
North	NOR060A	9.20	5.32	5.77	6.47	6.79	7.24	5.35	5.79	6.49	6.81	7.26
North	NOR060B	76.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
North	NOR070A	11.02	7.28	7.78	8.84	9.50	11.15	7.31	7.81	8.87	9.53	11.19
North	NOR070B	82.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Village Green	VLG000L	9.67	5.61	5.66	5.77	5.85	5.95	5.61	5.66	5.78	5.85	5.95
Village Green	VLG010L	9.76	2.38	2.38	2.39	2.39	2.40	2.38	2.38	2.39	2.39	2.40
Village Green	VLG020L	2.77	2.86	2.86	2.86	2.85	2.85	2.86	2.86	2.86	2.85	2.85
Village Green	VLG030L	4.41	1.61	1.62	1.64	1.65	1.65	1.62	1.62	1.64	1.65	1.65
Village Green	VLG040L	2.45	1.74	1.75	1.77	1.77	1.79	1.75	1.76	1.77	1.77	1.79
Village Green	WETLAND	0.67	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Village Green	VLG005A	3.82	7.14	7.21	7.36	7.47	7.64	7.14	7.21	7.37	7.48	7.64
Village Green	VLG005O	73.83	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Village Green	VLG015A	3.11	3.02	3.02	3.04	3.05	3.07	3.02	3.02	3.04	3.05	3.07
Village Green	VLG015O	71.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Village Green	VLG025A	6.65	5.35	5.48	5.67	5.80	6.02	5.36	5.48	5.68	5.81	6.02
Village Green	VLG025B	5.16	5.00	5.11	5.29	5.41	5.62	5.00	5.11	5.30	5.42	5.62
Village Green	VLG025O	55.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Village Green	VLG035A	7.79	6.51	6.51	6.51	6.46	6.40	6.51	6.51	6.51	6.45	6.40
Village Green	VLG035O	61.48	2.50	2.81	3.38	3.71	4.06	2.50	2.81	3.41	3.73	4.06
Sequoia	SEQ000L	4.45	1.20	1.23	1.28	1.28	1.28	1.21	1.24	1.28	1.28	1.28
Sequoia	SEQ020L	4.84	1.78	1.79	1.78	1.78	1.82	1.71	1.74	1.76	1.77	1.82
Sequoia	SEQ030L	3.60	0.43	0.43	0.43	0.43	0.52	0.62	0.64	0.66	0.65	0.66
Sequoia	SEQ035L	6.11	2.30	2.23	2.25	2.24	2.23	2.35	2.44	2.47	2.51	2.43
Sequoia	SEQ040L	5.88	1.78	1.78	1.82	1.81	1.75	1.86	1.88	1.96	1.96	2.00
Sequoia	SEQ045L	4.46	1.74	1.72	1.73	1.75	1.74	1.82	1.78	1.84	1.86	1.86
Sequoia	SEQ050L	4.97	1.64	1.63	1.63	1.64	1.66	1.75	1.70	1.72	1.75	1.75
Sequoia	SEQ055L	4.05	2.16	2.18	2.17	2.17	2.21	2.33	2.29	2.26	2.30	2.33

Table A-6. Model Results - Velocities

		Design	Present Velocities, fps					Future Velocities, fps				
Basin	Name	Vel, fps	2-year	5-year	10-year	25-year	100-year	2-year	5-year	10-year	25-year	100-year
Sequoia	SEQ060L	3.91	2.41	2.44	2.46	2.47	2.47	2.58	2.62	2.60	2.59	2.57
Sequoia	SEQ065L	4.60	2.20	2.26	2.35	2.38	2.39	2.36	2.43	2.53	2.56	2.58
Sequoia	SEQ070L	4.06	2.29	2.34	2.42	2.47	2.50	2.42	2.49	2.59	2.62	2.66
Sequoia	SEQ075L	5.34	2.38	2.43	2.51	2.55	2.60	2.50	2.56	2.66	2.69	2.74
Sequoia	SEQ080L	4.73	2.64	2.69	2.77	2.82	2.87	2.77	2.82	2.91	2.94	2.98
Sequoia	SEQ092L	11.68	-0.45	-0.52	-0.55	-0.61	-0.60	-0.46	-0.52	-0.55	-0.61	-0.60
Sequoia	SEQ100L	1.73	3.32	3.45	3.56	3.55	3.55	3.35	3.46	3.55	3.55	3.55
Sequoia	SEQ105L	1.00	2.69	2.96	3.34	3.57	3.78	2.75	2.99	3.40	3.63	3.77
Sequoia	SEQ125L	9.28	0.72	0.87	1.10	1.21	1.42	0.78	0.92	1.15	1.26	1.48
Sequoia	SEQ140L	4.75	0.92	1.00	1.20	1.29	1.47	0.92	1.04	1.25	1.34	1.52
Sequoia	SEQ150L	4.42	0.88	0.90	0.98	1.06	1.22	0.90	0.93	1.04	1.13	1.30
Sequoia	SEQ155L	7.67	2.96	2.93	2.94	2.90	2.96	2.94	2.93	2.94	2.92	2.94
Sequoia	SEQ165L	1.15	2.05	2.16	2.22	2.19	2.63	2.05	2.15	2.18	2.20	2.36
Sequoia	SEQ170L	3.41	1.96	2.20	2.52	2.78	3.54	1.98	2.22	2.55	2.84	3.62
Sequoia	SEQ175L	9.60	2.22	2.44	2.71	2.83	3.29	2.25	2.46	2.72	2.87	3.37
Sequoia	SEQ180L	7.76	2.95	3.09	3.30	3.38	3.54	2.98	3.10	3.32	3.39	3.48
Sequoia	SEQ185L	6.00	4.04	4.09	4.23	4.26	4.36	4.06	4.11	4.24	4.27	4.29
Sequoia	SEQ190L	2.87	1.11	1.17	1.30	1.29	1.39	1.09	1.16	1.27	1.26	1.29
Sequoia	SEQ195L	0.00	3.76	4.23	5.47	5.75	5.73	3.74	4.24	5.48	5.73	5.51
Sequoia	SEQ200L	2.60	3.02	3.56	4.69	4.89	4.81	3.03	3.57	4.70	4.87	4.80
Sequoia	SEQ205L	3.51	1.74	1.69	1.91	2.23	2.71	1.74	1.71	1.92	2.23	2.73
Sequoia	SEQ210L	6.04	0.31	0.36	0.41	0.41	0.81	0.30	0.36	0.41	0.41	0.75
Sequoia	SEQ220L	6.05	2.26	2.23	2.27	2.20	2.25	2.30	2.25	2.29	2.20	2.27
Sequoia	SEQ225L	7.19	2.82	2.88	3.00	3.06	3.19	2.85	2.90	3.02	3.08	3.23
Sequoia	SEQ230L	9.89	-0.38	-0.43	-0.52	-0.56	-0.66	-0.39	-0.45	-0.53	-0.57	-0.69
Sequoia	SEQ231L	0.00	3.57	3.62	3.60	3.62	3.68	3.59	3.62	3.59	3.63	3.69
Sequoia	SEQ235L	8.20	4.46	4.65	4.70	4.70	4.73	4.56	4.68	4.72	4.73	4.75
Sequoia	SEQ240L	9.26	5.78	5.99	6.28	6.46	6.50	5.84	6.04	6.38	6.53	6.52
Sequoia	SEQ245L	4.22	4.39	4.78	5.71	6.38	7.45	4.50	4.91	5.94	6.56	7.71
Sequoia	SEQ250L	8.47	2.25	2.47	3.18	3.60	4.37	2.35	2.58	3.39	3.78	4.69
Sequoia	SEQ255L	10.58	3.70	3.71	4.66	5.17	6.27	3.78	3.85	4.95	5.43	6.73
Sequoia	SEQ260L	10.56	5.69	5.70	5.74	5.75	5.71	5.72	5.72	5.76	5.77	5.72
Sequoia	SEQ265L	11.29	5.24	5.17	5.26	5.58	5.22	5.29	5.46	5.57	5.69	5.36
Sequoia	SEQ270L	16.70	9.44	9.72	10.17	10.36	10.68	9.61	9.88	10.34	10.53	10.85
Sequoia	SEQ275L	15.72	9.56	9.87	10.40	10.62	10.98	9.77	10.06	10.59	10.81	11.17

Table A-6. Model Results - Velocities

		Design	Present Velocities, fps					Future Velocities, fps				
Basin	Name	Vel, fps	2-year	5-year	10-year	25-year	100-year	2-year	5-year	10-year	25-year	100-year
Sequoia	SEQ280L	15.74	8.60	8.83	9.14	9.26	9.46	8.72	8.95	9.25	9.37	9.63
Sequoia	SEQ285L	12.12	8.52	8.86	9.44	9.66	10.03	8.71	51.00	9.64	9.86	10.21
Sequoia	SEQ290L	9.24	4.73	4.80	4.87	4.88	4.88	4.76	4.83	4.91	4.95	4.91
Sequoia	SEQ305L	5.55	3.09	3.18	3.41	3.51	3.76	3.14	3.23	3.45	3.58	3.85
Sequoia	SEQ310L	9.10	4.21	4.50	4.84	5.00	5.32	4.22	4.50	4.85	5.02	5.34
Sequoia	SEQ320L	11.95	3.44	3.68	3.86	4.03	3.99	3.44	3.67	3.86	4.04	3.99
Sequoia	SEQ330L	11.87	1.99	2.04	2.11	2.21	2.61	2.00	2.04	2.11	2.23	2.62
Sequoia	SEQ340L	17.58	1.85	1.83	1.95	2.15	2.56	1.85	1.84	1.96	2.17	2.58
Sequoia	SEQ360L	9.41	4.51	4.55	4.52	4.48	4.52	4.56	4.60	4.55	4.51	4.57
Sequoia	SEQ365L	5.30	3.95	4.08	4.26	4.32	4.40	3.98	4.11	4.29	4.36	4.46
Sequoia	SEQ370L	4.29	3.24	3.36	3.59	3.69	3.87	3.29	3.41	3.64	3.75	3.95
Sequoia	SEQ375L	15.39	2.75	2.90	3.22	3.30	3.57	2.72	2.90	3.23	3.32	3.67
Sequoia	SEQ380L	14.37	8.08	8.05	8.05	8.06	8.12	8.04	8.03	8.05	8.09	8.17
Sequoia	SEQ385L	14.50	8.14	8.35	8.66	8.77	9.05	8.16	8.36	8.65	8.77	9.07
Sequoia	SEQ390L	18.52	8.40	8.32	8.35	8.40	8.46	8.40	8.36	8.36	8.43	8.47
Sequoia	SEQ005A	8.66	5.64	6.06	7.20	8.19	9.43	5.69	6.11	7.31	8.28	9.48
Sequoia	SEQ005O	84.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sequoia	SEQ025A	8.74	4.52	4.88	5.38	5.72	5.98	4.64	4.98	5.49	5.82	6.03
Sequoia	SEQ025O	146.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sequoia	SEQ120A	11.49	3.81	3.97	4.20	4.35	5.15	3.85	4.00	4.24	4.40	5.22
Sequoia	SEQ120O	8.17	4.26	4.27	4.24	4.30	4.88	4.21	4.21	4.25	4.28	4.94
Sequoia	SEQ120O	16.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sequoia	SEQ130A	2.29	6.30	6.42	6.54	6.59	6.63	6.35	6.45	6.56	6.60	6.64
Sequoia	SEQ130O	28.07	3.70	4.55	5.53	5.92	6.61	4.09	4.79	5.71	6.11	6.77
Sequoia	SEQ145A	1.77	6.31	6.34	6.34	6.34	6.32	6.35	6.33	6.37	6.36	6.34
Sequoia	SEQ145O	32.39	1.70	2.33	3.26	3.60	4.19	2.06	2.65	3.56	3.89	4.51
Sequoia	SEQ160A	5.95	1.64	1.83	2.39	2.81	3.32	1.67	1.86	2.51	2.89	3.40
Sequoia	SEQ160B	5.07	1.55	1.75	2.33	2.74	3.24	1.59	1.78	2.45	2.82	3.32
Sequoia	SEQ160C	6.51	1.66	1.86	2.42	2.84	3.36	1.70	1.89	2.54	2.93	3.44
Sequoia	SEQ160O	8.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sequoia	SEQ315A	4.81	4.23	4.57	5.15	5.48	6.35	4.24	4.58	5.17	5.50	6.42
Sequoia	SEQ315O	47.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sequoia	SEQ325A	3.17	5.35	6.31	7.91	8.06	8.22	5.38	6.37	7.93	8.07	8.23
Sequoia	SEQ325O	56.40	0.00	0.00	1.03	2.31	4.39	0.00	0.00	1.14	2.40	4.47
Sequoia	SEQ335A	2.64	6.58	7.26	7.50	7.57	7.69	6.64	7.28	7.50	7.58	7.70

Table A-6. Model Results - Velocities

		Design	Present Velocities, fps					Future Velocities, fps				
Basin	Name	Vel, fps	2-year	5-year	10-year	25-year	100-year	2-year	5-year	10-year	25-year	100-year
Sequoia	SEQ335O	49.81	0.00	2.01	4.61	5.54	7.05	0.00	2.14	4.69	5.61	7.11
Sequoia	SEQ345A	9.70	5.89	6.13	6.54	6.73	7.11	5.91	6.14	6.56	6.75	7.13
Sequoia	SEQ345O	55.68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Garfield	GAR000L	76.95	10.50	10.78	11.10	12.30	14.42	10.54	10.80	11.11	12.60	14.54
Garfield	GAR010L	6.41	2.14	2.15	2.19	2.18	2.22	2.16	2.18	2.19	2.19	2.25
Garfield	GAR015L	3.58	1.35	1.51	1.31	1.36	1.47	1.29	1.40	1.50	1.46	1.42
Garfield	GAR025L	2.78	0.82	0.82	0.83	0.83	0.85	0.83	0.83	0.84	0.85	0.85
Garfield	GAR035L	6.58	0.62	0.64	0.64	0.64	0.65	0.67	0.66	0.67	0.66	0.69
Garfield	GAR040L	9.53	1.40	1.44	1.49	1.48	1.41	1.42	1.47	1.51	1.47	1.43
Garfield	GAR045L	5.71	3.94	4.17	4.52	4.71	4.88	4.07	4.29	4.63	4.79	4.98
Garfield	GAR050L	5.08	3.61	3.68	3.85	3.93	4.16	3.64	3.71	3.89	4.01	4.24
Garfield	GAR055L	9.31	3.42	3.50	3.68	3.75	3.97	3.43	3.50	3.70	3.79	4.08
Garfield	GAR060L	17.38	3.44	3.61	3.97	4.16	4.34	3.50	3.60	3.96	4.14	4.35
Garfield	GAR065L	2.27	2.77	2.91	3.60	3.84	3.97	2.78	2.92	3.58	3.84	3.95
Garfield	GAR070L	2.34	1.83	1.92	2.40	2.70	3.31	1.83	1.91	2.37	2.70	3.31
Garfield	GAR075L	2.44	1.98	2.04	2.40	2.70	3.30	1.98	2.04	2.40	2.70	3.31
Garfield	GAR080L	6.15	1.38	1.42	1.47	1.51	1.74	1.30	1.31	1.35	1.54	1.79
Garfield	GAR085L	1.99	1.54	1.74	2.37	2.62	3.09	1.55	1.91	2.47	2.73	3.15
Garfield	GAR090L	1.81	1.58	1.78	2.36	2.62	3.09	1.55	1.91	2.46	2.73	3.14
Garfield	GAR095L	1.86	0.68	0.73	0.94	1.04	1.28	0.71	0.73	0.94	1.04	1.32
Garfield	GAR100L	4.44	2.02	2.01	2.04	2.04	2.07	2.03	2.04	2.07	2.09	2.11
Garfield	GAR105L	4.22	2.20	2.18	2.23	2.25	2.27	2.22	2.24	2.28	2.29	2.29
Garfield	GAR110L	4.36	2.27	2.25	2.24	2.26	2.27	2.28	2.24	2.27	2.26	2.30
Garfield	GAR120L	3.87	2.49	2.54	2.56	2.54	2.48	2.54	2.58	2.57	2.56	2.51
Garfield	GAR125L	4.81	2.67	2.74	2.87	2.91	2.93	2.73	2.80	2.91	2.94	2.94
Garfield	GAR130L	4.15	2.61	2.70	2.86	2.93	3.03	2.68	2.77	2.92	2.98	3.09
Garfield	GAR135L	2.45	-1.50	-1.58	-1.74	-1.83	-2.04	-1.42	-1.51	-1.68	-1.76	-1.99
Garfield	GAR140L	3.87	1.43	1.50	1.64	1.72	1.94	1.34	1.42	1.58	1.68	1.91
Garfield	GAR145L	2.65	1.33	1.34	1.37	1.38	1.42	1.24	1.26	1.29	1.30	1.38
Garfield	GAR150L	11.74	2.34	2.37	2.43	2.43	2.40	2.32	2.37	2.38	2.36	17.00
Garfield	GAR005A	8.50	7.11	7.60	8.16	8.68	9.53	7.18	7.62	8.18	8.78	9.53
Garfield	GAR005B	78.62	0.00	0.00	0.00	12.10	16.10	0.00	0.00	0.00	13.74	16.16
Garfield	GAR020A	1.92	4.25	4.54	5.06	5.31	5.78	4.30	4.58	5.10	5.36	5.85
Garfield	GAR020B	83.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Garfield	GAR030A	2.01	2.72	2.85	3.06	3.16	3.37	2.84	2.97	3.17	3.28	3.50

Table A-6. Model Results - Velocities

		Design	Present Velocities, fps					Future Velocities, fps				
Basin	Name	Vel, fps	2-year	5-year	10-year	25-year	100-year	2-year	5-year	10-year	25-year	100-year
Garfield	GAR030B	75.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oak	OAK005L	11.46	6.50	7.16	7.45	7.52	7.66	6.53	7.19	7.48	7.55	7.68
Oak	OAK015L	8.37	5.86	6.01	6.03	6.04	6.04	5.87	6.02	6.04	6.04	6.04
Oak	OAK025L	16.92	5.54	5.87	5.97	6.00	6.04	5.55	5.88	5.98	6.01	6.05
Oak	OAK033L	6.34	5.70	6.17	6.35	6.39	6.47	5.71	6.19	6.36	6.41	6.49
Oak	OAK035L	23.49	6.15	6.87	7.06	7.11	7.21	6.17	6.89	7.08	7.13	7.23
Oak	OAK045L	5.61	6.07	6.50	6.62	6.65	6.71	6.09	6.52	6.63	6.66	6.72
Oak	OAK060L	5.93	4.97	5.43	5.57	5.60	5.67	4.99	5.45	5.58	5.62	5.69
Oak	OAK080L	8.74	4.91	5.23	5.30	5.32	5.35	4.92	5.24	5.31	5.33	5.36
Oak	OAK090L	10.85	5.06	5.28	5.34	5.37	5.39	5.07	5.29	5.35	5.37	5.40
Oak	OAK100L	8.39	7.44	8.05	8.18	8.20	8.26	7.46	8.07	8.19	8.21	8.27
Oak	OAK103L	9.02	6.12	6.24	6.26	6.34	6.31	6.10	6.24	6.26	6.33	6.31
Oak	OAK105L	8.77	5.08	5.75	5.82	5.83	5.84	5.09	5.77	5.83	5.83	5.84
Oak	OAK110L	7.16	5.43	5.94	5.99	6.03	6.05	5.44	5.95	5.99	6.03	6.05
Oak	OAK120L	8.94	3.11	3.15	3.13	3.12	3.12	3.11	3.15	3.13	3.12	3.12
Oak	OAK125L	7.15	5.32	5.40	5.29	5.29	5.21	5.24	5.27	5.22	5.23	5.15
Oak	OAK130L	5.40	4.73	5.20	7.97	9.25	11.21	4.70	5.21	7.97	9.25	11.21
Oak	OAK140L	8.41	5.80	6.00	6.04	6.70	7.12	5.77	5.98	6.04	6.70	7.12
Oak	OAK150L	15.25	6.00	6.29	6.49	6.50	7.27	6.00	6.29	6.49	6.50	7.27
Oak	OAK155L	3.85	4.59	5.10	6.36	7.10	8.38	4.59	5.10	6.36	7.10	8.38
Oak	OAK170L	12.67	4.96	5.36	5.75	5.91	6.03	4.96	5.36	5.75	5.91	6.03
Oak	OAK205L	10.94	7.49	8.10	9.03	9.40	9.91	7.49	8.10	9.03	9.40	9.91
Oak	OAK215L	14.48	1.37	1.50	1.73	1.91	2.34	1.37	1.51	1.73	1.91	2.34
Oak	OAK225L	22.18	0.86	1.16	1.25	-1.67	-2.01	1.40	1.35	1.49	-1.78	2.29
Oak	OAK235L	8.48	2.42	2.31	2.50	2.58	2.56	2.56	2.55	2.61	2.61	2.63
Oak	OAK245L	9.07	1.68	2.03	2.56	2.76	3.08	1.74	2.09	2.61	2.81	3.12
Oak	OAK255L	4.63	0.55	0.46	0.50	0.55	0.64	0.53	0.42	0.51	0.56	0.60
Oak	OAK280L	12.41	4.84	4.83	5.07	5.33	5.42	4.83	4.84	5.14	5.39	5.42
Oak	OAK290L	18.56	2.86	3.08	2.84	2.87	2.90	3.23	2.92	3.00	3.14	3.31
Oak	OAK295L	10.08	3.32	3.42	3.12	3.26	3.87	3.09	3.15	2.93	3.21	3.87
Oak	OAK305L	9.98	6.26	6.51	6.14	6.07	6.86	6.27	6.41	5.95	6.03	6.85
Oak	OAK310L	9.98	6.17	6.52	6.79	6.61	6.86	6.28	6.63	6.77	6.60	6.85
Oak	OAK315L	9.98	5.55	5.82	5.88	5.90	5.94	5.61	5.83	5.91	5.90	5.96
Oak	OAK325L	10.00	4.76	5.01	5.38	5.59	5.39	4.77	5.08	5.34	5.41	5.38
Oak	OAK330L	6.05	3.59	3.78	4.08	4.36	4.38	3.63	3.80	4.09	4.36	4.38

Table A-6. Model Results - Velocities

		Design	Present Velocities, fps					Future Velocities, fps				
Basin	Name	Vel, fps	2-year	5-year	10-year	25-year	100-year	2-year	5-year	10-year	25-year	100-year
Oak	OAK335L	6.08	3.55	3.77	3.94	4.12	4.14	3.58	3.80	3.95	4.12	4.13
Oak	OAK340L	6.10	3.26	3.50	3.69	3.74	3.80	3.30	3.54	3.69	3.74	3.80
Oak	OAK345L	6.07	3.64	3.87	4.01	4.03	4.08	3.68	3.90	4.01	4.02	4.08
Oak	OAK350L	6.81	1.10	1.09	1.05	1.06	1.10	1.01	0.97	1.00	1.02	1.05
Oak	OAK355L	3.07	3.43	3.64	4.11	4.44	4.43	3.42	3.63	4.43	4.43	4.43
Oak	OAK365L	3.08	2.81	2.90	3.82	3.87	3.80	2.84	3.03	3.80	3.88	3.80
Oak	OAK370L	3.08	3.21	3.17	3.80	3.84	3.78	3.20	3.17	3.79	3.86	3.78
Oak	OAK375L	10.81	-3.33	-3.40	-5.04	-5.04	-5.04	-3.39	-3.39	-5.04	-5.05	-5.04
Oak	OAK376L	6.93	4.93	5.32	5.54	5.29	5.41	5.18	5.42	5.50	5.38	5.45
Oak	OAK380L	5.53	3.33	3.64	3.86	3.90	3.97	3.39	3.68	3.86	3.90	3.97
Oak	OAK385L	5.46	2.61	2.79	2.95	2.98	2.98	2.87	2.93	3.03	2.99	2.99
Oak	OAK390L	5.46	3.20	3.32	3.52	3.51	3.47	3.26	3.39	3.59	3.51	3.47
Oak	OAK395L	5.45	3.27	3.51	3.66	3.63	3.59	3.34	3.53	3.65	3.58	3.58
Oak	OAK400L	3.28	3.13	4.26	5.34	5.36	5.38	3.25	4.57	5.37	5.36	5.38
Oak	OAK405L	3.23	2.81	4.11	5.29	5.30	5.31	2.87	4.49	5.30	5.30	5.31
Oak	OAK410L	3.23	2.81	4.10	5.25	5.26	5.27	2.87	4.47	5.26	5.26	5.27
Oak	OAK415L	3.24	2.13	2.75	3.67	3.90	3.68	2.54	3.12	3.96	3.96	3.82
Oak	OAK420L	6.96	3.76	3.92	3.90	3.99	3.85	3.83	3.99	4.00	4.03	3.92
Oak	OAK010A	11.08	7.44	8.05	8.32	8.39	8.52	7.46	8.08	8.35	8.41	8.54
Oak	OAK010O	40.97	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oak	OAK020A	15.90	2.43	2.68	2.78	2.80	2.85	2.43	2.69	2.79	2.81	2.85
Oak	OAK020O	74.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oak	OAK030A	14.64	5.13	5.68	5.89	5.95	6.05	5.15	5.70	5.92	5.97	6.07
Oak	OAK030O	52.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oak	OAK040A	17.37	5.98	6.45	6.61	6.65	6.72	5.99	6.47	6.62	6.66	6.74
Oak	OAK040O	45.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oak	OAK065A	15.94	2.26	2.59	2.69	2.71	2.76	2.27	2.61	2.70	2.72	2.77
Oak	OAK065O	36.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oak	OAK085A	22.50	5.28	5.79	5.92	5.96	6.02	5.30	5.81	5.94	5.97	6.04
Oak	OAK085O	72.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oak	OAK115A	7.46	8.85	11.13	11.22	11.22	11.23	8.91	11.15	11.22	11.22	11.23
Oak	OAK115O	38.14	0.00	0.73	1.29	1.35	1.42	0.00	0.87	1.29	1.36	1.43
Oak	OAK135A	9.73	3.05	3.74	5.72	6.42	7.00	3.03	3.75	5.72	6.42	7.00
Oak	OAK135O	38.22	0.00	0.00	0.00	1.65	6.96	0.00	0.00	0.00	1.66	6.96
Oak	OAK145A	9.40	6.55	7.40	8.45	9.38	11.69	6.56	7.40	8.45	9.38	11.70

Table A-6. Model Results - Velocities

		Design	Present Velocities, fps					Future Velocities, fps				
Basin	**Name**	**Vel, fps**	**2-year**	**5-year**	**10-year**	**25-year**	**100-year**	**2-year**	**5-year**	**10-year**	**25-year**	**100-year**
Oak	OAK145O	37.07	0.00	0.00	0.00	0.00	0.77	0.00	0.00	0.00	0.00	0.78
Oak	OAK160A	10.48	3.57	4.11	4.65	4.74	6.24	3.57	4.11	4.65	4.74	6.24
Oak	OAK160O	7.49	0.00	0.00	0.00	0.00	4.30	0.00	0.00	0.00	0.00	4.30
Oak	OAK230A	5.97	3.45	3.43	4.08	3.95	3.80	3.66	3.72	4.49	4.35	4.09
Oak	OAK230O	23.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oak	OAK240A	7.83	1.51	1.62	2.01	2.25	2.69	1.51	1.61	2.00	2.19	2.65
Oak	OAK240O	15.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oak	OAK250A	15.78	2.82	3.05	3.50	3.52	3.70	2.65	2.82	3.17	3.31	3.54
Oak	OAK250O	21.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oak	OAK260A	4.14	2.30	2.46	2.75	2.88	3.11	2.39	2.54	2.83	2.96	3.19
Oak	OAK260O	5.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oak	OAK285A	4.31	3.42	4.04	4.91	5.25	5.63	3.56	4.15	5.00	5.33	5.69
Oak	OAK285O	4.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Marys River	MRY001A	10.28	3.49	3.70	4.48	4.92	5.64	3.54	3.80	4.75	5.20	6.04
Marys River	MRY001B	56.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Marys River	MRY003A	8.69	2.77	2.81	3.02	3.18	3.59	2.77	2.86	3.11	3.30	3.83
Marys River	MRY003B	52.82	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Marys River	MRY005A	29.75	8.49	8.00	8.31	8.42	8.63	7.80	8.09	8.32	8.43	8.64
Marys River	MRY005B	84.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Goodnight	GDN005L	5.07	3.91	4.22	4.70	4.91	5.30	4.28	4.60	5.10	5.30	5.82
Goodnight	GDN010L	4.52	3.15	3.35	3.65	3.78	4.11	3.39	3.59	3.92	4.11	4.87
Goodnight	GDN015L	5.11	3.17	3.32	3.53	3.64	3.91	3.37	3.50	3.74	3.92	4.92
Goodnight	GDN030L	6.74	4.06	4.17	4.32	4.35	4.39	4.15	4.20	4.30	4.28	5.24
Goodnight	GDN035L	5.13	3.77	4.02	4.23	4.27	4.35	3.91	4.00	4.03	4.05	4.13
Goodnight	GDN040L	5.09	2.54	2.72	2.99	3.09	3.23	2.28	2.51	2.71	2.74	3.02
Goodnight	GDN045L	2.93	2.26	2.59	3.74	4.17	5.21	2.13	2.62	3.71	4.18	5.51
Goodnight	GDN050L	7.70	1.48	1.47	1.98	2.10	2.35	1.48	1.47	1.99	2.12	3.30
Goodnight	GDN055L	3.90	2.31	2.34	2.36	2.36	2.42	2.27	2.37	2.31	2.35	2.38
Goodnight	GDN060L	5.79	1.61	1.62	1.59	1.72	1.86	1.52	1.66	1.63	1.77	1.96
Goodnight	GDN065L	7.55	2.52	2.51	2.48	2.46	2.48	2.46	2.47	2.47	2.51	2.56
Goodnight	GDN075L	4.23	2.54	2.64	2.66	2.60	2.63	2.61	2.65	2.57	2.56	2.57
Goodnight	GDN085L	7.12	2.19	2.24	2.32	2.31	2.29	2.05	2.11	2.19	2.14	2.53
Goodnight	GDN090L	5.46	3.30	3.49	3.58	3.61	3.58	3.30	3.49	3.55	3.53	3.52
Goodnight	GDN095L	1.29	1.30	1.37	1.75	1.76	1.80	1.30	1.36	1.76	1.76	1.84
Goodnight	GDN100L	4.72	1.27	1.29	1.56	1.57	1.57	1.27	1.29	1.58	1.57	1.58

Table A-6. Model Results - Velocities

Basin	Name	Design Vel, fps	Present Velocities, fps 2-year	5-year	10-year	25-year	100-year	Future Velocities, fps 2-year	5-year	10-year	25-year	100-year
Goodnight	GDN105L	3.81	1.24	1.21	1.21	1.19	1.23	1.23	1.20	1.19	1.20	1.30
Goodnight	GDN110L	3.65	1.39	1.39	1.37	1.38	1.39	1.39	1.39	1.37	1.38	1.41
Goodnight	GDN115L	1.34	1.29	1.33	1.40	1.38	1.37	1.29	1.32	1.41	1.38	1.37
Goodnight	GDN120L	2.67	1.26	1.30	1.39	1.42	1.40	1.26	1.30	1.40	1.43	1.38
Goodnight	GDN125L	2.63	1.44	1.49	1.63	1.69	1.70	1.44	1.49	1.63	1.68	1.65
Goodnight	GDN130L	3.01	1.58	1.63	1.75	1.79	1.84	1.58	1.63	1.75	1.79	1.79
Goodnight	GDN135L	3.00	1.69	1.75	1.87	1.91	1.96	1.69	1.75	1.87	1.91	1.95
Goodnight	GDN140L	3.55	2.05	2.13	2.27	2.34	2.45	2.05	2.13	2.27	2.34	2.45
Goodnight	GDN145L	2.00	0.67	0.69	0.73	0.70	0.75	0.67	0.69	0.73	0.70	-1.54
Goodnight	GDN150L	2.36	1.30	1.32	1.27	1.24	1.32	1.30	1.32	1.27	1.24	1.32
Goodnight	GDN155L	2.15	0.57	0.49	0.51	0.51	0.52	0.57	0.49	0.51	0.51	-0.96
Goodnight	GDN160L	2.51	1.33	1.33	1.27	1.28	1.32	1.33	1.33	1.27	1.28	1.32
Goodnight	GDN165L	2.49	1.38	1.47	1.62	1.68	1.68	1.38	1.47	1.62	1.68	1.68
Goodnight	GDN185a	8.29	0.00	0.00	2.37	3.70	5.13	6.58	6.59	6.59	6.58	6.61
Goodnight	GDN185b	18.97	0.00	0.00	0.00	0.00	0.00	2.47	3.01	3.78	4.15	4.72
Goodnight	GDN190L	0.00	-0.62	-0.75	-0.68	-0.70	-0.75	1.08	1.34	1.96	2.29	2.94
Goodnight	GDN500L	3.71	2.08	2.08	2.03	2.05	2.06	2.96	2.96	2.97	2.98	2.97
Goodnight	GDN510L	4.97	2.09	2.09	2.10	2.08	2.09	2.48	2.63	2.68	2.66	2.66
Goodnight	GDN515L	4.76	2.40	2.47	2.49	2.49	2.48	2.79	2.88	2.92	2.92	2.91
Goodnight	GDN520L	5.25	2.51	2.67	2.81	2.85	2.88	3.14	3.19	3.23	3.24	3.21
Goodnight	GDN525L	4.06	1.71	1.82	1.95	2.09	2.25	2.55	2.56	2.57	2.57	2.58
Goodnight	GDN530L	3.25	1.69	1.83	2.04	2.13	2.27	0.94	0.95	1.04	1.17	1.28
Goodnight	GDN535L	3.77	2.09	2.25	2.47	2.56	2.69	1.78	1.89	2.08	2.20	2.34
Goodnight	GDN540L	3.96	1.82	1.98	2.17	2.21	2.26	2.00	2.13	2.30	2.34	2.36
Goodnight	GDN545L	2.50	1.54	1.69	1.90	1.99	2.14	1.70	1.83	2.03	2.13	2.31
Goodnight	GDN550L	3.70	1.89	2.02	2.16	2.21	2.30	2.06	2.15	2.28	2.33	2.43
Goodnight	GDN555L	0.00	-0.48	-0.64	-0.93	-1.01	-1.15	n/a	n/a	n/a	n/a	n/a
Goodnight	GDN560L	0.00	-0.78	-0.78	-0.81	-0.81	-0.76	n/a	n/a	n/a	n/a	n/a
Goodnight	GDN565L	0.75	-0.59	-0.59	-0.59	-0.59	-0.59	n/a	n/a	n/a	n/a	n/a
Goodnight	GDN570L	1.41	2.47	2.59	2.59	2.59	2.59	n/a	n/a	n/a	n/a	n/a
Goodnight	GDN575L	1.16	0.55	0.55	0.55	0.55	0.51	n/a	n/a	n/a	n/a	n/a
Goodnight	GDN580L	0.97	-0.54	-0.54	0.63	0.68	0.68	n/a	n/a	n/a	n/a	n/a
Goodnight	GDN585L	0.50	0.43	0.50	0.50	0.50	0.50	n/a	n/a	n/a	n/a	n/a
Mill Race	MIL005L	16.62	3.30	3.57	4.23	4.48	4.89	3.46	3.79	4.38	4.61	5.02
Mill Race	MIL015L	5.05	0.47	0.52	0.63	0.68	0.75	0.50	0.56	0.66	0.70	0.77

Table A-6. Model Results - Velocities

Basin	Name	Design Vel, fps	Present Velocities, fps 2-year	5-year	10-year	25-year	100-year	Future Velocities, fps 2-year	5-year	10-year	25-year	100-year
Mill Race	MIL025L	19.58	-0.21	-0.24	-0.32	-0.38	-0.41	-0.25	-0.27	-0.34	-0.37	-0.42
Mill Race	MIL040L	15.53	0.90	0.84	1.09	1.18	1.34	0.87	0.94	1.16	1.24	1.39
Mill Race	MIL050L	3.31	1.14	1.15	1.13	1.16	1.28	1.11	1.13	1.14	1.16	1.29
Mill Race	MIL055L	3.11	1.44	1.45	1.51	1.48	1.55	1.41	1.42	1.43	1.43	1.55
Mill Race	MIL075L	3.31	-0.49	-0.52	-0.54	-0.57	-0.62	-0.49	-0.52	-0.54	-0.57	-0.63
Mill Race	MIL085L	5.31	0.13	0.16	0.20	0.21	0.24	0.14	0.16	0.20	0.22	0.25
Mill Race	MIL090L	5.49	0.00	0.00	-0.07	-0.09	-0.13	0.00	-0.04	-0.10	-0.12	-0.13
Mill Race	MIL010A	4.13	2.82	3.02	3.49	3.66	3.95	2.93	3.18	3.60	3.76	4.05
Mill Race	MIL010B	3.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mill Race	MIL020A	11.60	2.05	2.14	2.37	2.45	2.60	2.10	2.22	2.42	2.50	2.65
Mill Race	MIL020B	9.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mill Race	MIL030A	15.50	0.20	0.22	0.32	0.36	0.43	0.21	0.22	0.32	0.37	0.44
Mill Race	MIL030B	9.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mill Race	MIL045A	10.57	0.60	0.62	0.65	0.71	0.82	0.60	0.61	0.66	0.72	0.83
Mill Race	MIL045B	8.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mill Race	MIL060A	3.01	0.37	0.40	0.45	0.49	0.56	0.37	0.40	0.46	0.50	0.57
Mill Race	MIL060B	2.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mill Race	MIL080A	2.94	0.46	0.58	0.73	0.80	0.98	0.47	0.58	0.74	0.82	1.00
Mill Race	MIL080B	4.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

APPENDIX D
TECHNICAL MEMORANDUM NO. 2

Basis of Costs

TECHNICAL MEMORANDUM No. 2

TO: Bruce Moser, Project Manager, City of Corvallis

FROM: Jim Hansen, Project Manager

DATE: December 2000

PREPARED BY: Dave Felstul, Brown and Caldwell

REVIEWED BY: Walt Meyer, West-Yost

SUBJECT: Basis for Project Costs

PROJECT: Corvallis Stormwater Master Plan

CONTENTS

TABLES

This technical memorandum briefly documents the assumptions used to prepare the cost estimates for the Corvallis Stormwater Master Plan (SWMP). The watershed projects recommended in the SWMP can be classified as one of two main types, engineered structural solutions and riparian enhancement activities. Examples of engineered structures include culverts, detention ponds, and underground treatment devices. They require engineering analysis for sizing and placement. Examples of riparian enhancement activities include removal of invasive weeds, planting of trees, and placement of geotextile fabric for erosion control.

1.0 BASIS OF COST ESTIMATES

Costs of a project vary depending on the specific conditions of the project site. The accuracy of the cost estimate, therefore, is very dependent on the amount of information available on the site, as discussed below.

Type of Estimate. The costs developed for the SWMP are planning level costs or order-of-magnitude estimates as defined below, and not budget estimates or definitive estimates.

> **Order-of-Magnitude Estimate.** An order-of-magnitude estimate is approximate and is made without detailed engineering data. Techniques such as cost-capacity curves, scale-up or scale-down factors, and ratios are used in developing such an estimate. Typically a cost estimate of this kind is considered accurate within a range of +50 percent or -30 percent. That is, the final cost may be as much as 50 percent more or 30 percent less than the estimated amount.
>
> **Budget Estimate.** In this case, budget applies to the owner's budget and not to the budget as a project control document. This estimate is prepared based on field observations, or using process flow sheets, layouts, and equipment details. An estimate of this type is normally accurate within +30 percent or -15 percent.
>
> **Definitive Estimate.** As the name implies, this is an estimate prepared from well-defined engineering data such as construction plans and specifications. As a minimum, the data must include the following: fairly comprehensive plot plans and elevations, piping and instrument diagrams, one-line electrical diagrams, equipment data sheets and quotations, structural drawings, soil data and drawings, and a complete set of specifications. The maximum definitive estimate would be made from approved for construction drawings and specifications. The accuracy of a definitive estimate would fall within +15 percent or –5 percent.

Cost Index. All costs were updated using the ENR Construction Cost Index of 6300, approximately that for June 2000. The costs for acquisition of land or easements were not included for any of the engineered or riparian enhancement alternatives.

Provisions for Engineering, Administration, and Contingencies. Other project costs have been assumed to be equal to 45 percent of the construction costs of the project. This includes 20 percent for engineering, 5 percent for administration, and 20 percent for contingency. The same percentage was assumed for both engineered and restoration projects because, although the restoration projects typically involve less engineering, they require a lot of permitting effort.

2.0 CONSTRUCTION COSTS FOR ENGINEERED STRUCTURES

Cost estimates for engineered structures are based largely on equations which relate to the volume of stormwater runoff treated, the amount of impervious surface draining to a facility, or the excavated size of the facility. The equations were based on compilations of costs for similar structures across the United States (EPA, 1999; Center for Watershed Protection, 1997). Where possible, costs were checked against those for projects completed within Oregon and Washington. All costs were adjusted as noted above for June 2000.

Detention Ponds. The equation used to estimate the cost of constructing detention ponds is based on the relationship between pond storage volume and total construction cost (Center for Watershed Protection, 1997). The equation is:

$$CC = 20.80 \times Vs^{0.70} \times 1.08$$

Where CC = construction cost
Vs = storage volume up to the crest of emergency spillway in cubic feet
1.08 = adjustment factor to update costs from 1997 to 2000

The construction cost for stormwater detention ponds includes excavation, grading and control structure costs. It is assumed that detention facilities will be designed with a pond cell where sediment will accumulate, such as a forebay in a wet detention pond.

Constructed Wetland. To estimate the cost of building a constructed wetland, begin with the cost for a detention pond and increase it by 25 percent to account for the extra plant selection and sediment forebay requirements (EPA, 1999).

For comparison, the costs of constructing off-channel wetlands for Portland, Oregon (USA, 1998) and in Washington County, Oregon (USA, 1997), were about $2.50 and $4.00 per square foot, respectively.

Grassed Swales and Filter Strips. The cost of creating a grassed swale is approximately $0.65 per cubic foot of volume (EPA, 1999). The cost of a filter strip is $1.30 per cubic foot of volume. Costs for both types of facilities assume 6 inches of water depth storage in the swale.

Infiltration Trench. Infiltration trench costs range from $2.10 to $4.25 and average $2.65 per cubic foot of treatment value (EPA, 1999). This assumes a porosity of 32 percent in the fill material of the trench.

Sand Filters (Underground Vault). The costs of sand filters range from $2.10 to $6.40 per cubic foot of treatment volume, with a mean cost of $2.65 (Brown and Schueler, 1997). The cost for the underground vault configuration used in the Washington, DC area is approximately $16,000 (EPA, 1999).

Porous Pavement. Average porous pavement costs were reported to be $65,000 per acre (EPA, 1999).

Floodproofing. The cost for elevating a wood frame building on foundation walls was assumed to be $25 per square foot (USACE, 1993).

Culverts. Unit prices for culvert replacement are based on the typical unit prices for new pipe presented in Table TM2-1. They include AC saw cut, AC patch, trench excavation, pipe bedding, trench backfill, and shoring. The table assumes C14 pipe to 15 inches, C76 pipe to 36 inches, corrugated metal pipe to 54 inches, and steel arch pipe larger than 54 inches.

Table TM2-1. Unit Price Per Foot for New Pipe[1]

Pipe diameter, inches	Depth to invert, feet->								
	4	6	8	10	12	14	16	18	20
8	41	50	59	67	76	84	93	103	111
10	45	54	63	72	81	90	99	109	118
12	47	57	66	76	85	95	105	115	125
15	51	61	71	82	92	102	112	123	134
18	64	75	86	97	108	119	130	142	153
21	69	80	92	104	115	127	139	151	163
24	78	91	103	115	128	140	153	166	179
27	86	99	112	125	139	152	165	179	193
30	95	109	123	137	151	165	179	194	208
36	109	135	151	167	182	198	214	230	246
42	104	144	160	176	191	207	223	239	255
48		162	179	196	213	230	247	265	282
54		180	199	217	235	254	272	291	310
60			237	256	276	296	316	336	356
66			279	303	326	350	374	399	422
72			306	331	356	381	406	432	457
84				374	402	430	458	487	515

[1]Updated from Beaverton, 1994 with assistance of Brown and Caldwell cost estimator.

The cost for diverting flow during culvert construction was added to each culvert replacement project. Flow diversion costs were based on the application of a 25 percent factor to the replacement pipe cost, and they include the installation, removal, and maintenance of dams, pumps, and pipes for an average duration of 4 months. Actual flow diversion costs may be less since construction would typically take place during low flow conditions.

Culvert entrance structures protect the embankment from erosion and may improve the hydraulic characteristics of the culvert. Culvert outlet structures protect the downstream slope of the fill from erosion and prevent undercutting of the culvert barrel. Construction costs for new entrance and outlet structures are estimated to be $2,000 for culvert diameters less than or equal to 48 inches and $4,000 for culvert diameters greater than 48 inches for each structure (BES, 1998). Construction costs for retrofitting entrance and outlet structures were based on the application of a 25 percent factor to the new structure cost to account for demolition costs.

Bridges and Box Culverts. If too many parallel culverts are required to route the modeled flow, a bridge, box culvert, or pipe arch was recommended. The structure was sized to pass the 25-year future flows. Cost was estimated based on a simple concrete bridge design with no footing problems. A two-lane bridge was priced at $2,500 per linear foot. A four lane bridge at $6,000 per linear foot. Costs would likely be less if a box culvert or a pipe arch is used. A final decision on the best choice of structure cannot be made prior to predesign work.

3.0 COSTS FOR RIPARIAN ENHANCEMENT

The estimates of costs for riparian restoration are based on costs for materials and labor for similar activities in other locations. Riparian restoration costs are normally calculated by multiplying the square foot of material, per plant, or per volume excavated. To allow for estimation, unit costs were combined into a cost per 100 lineal feet of streambank restoration that was used for most cost estimates. This allowed estimation of project costs without the detailed survey information required for budget or definitive estimates.

Costs for stream and riparian enhancement are site dependent. Site access, soils, existing vegetation, and source of labor (many are volunteer projects) are all examples of factors that influence costs. Unit costs for several typical riparian enhancement projects were developed from detailed project descriptions in the Beaverton Creek Watershed Master Plan, recently completed for the Unified Sewerage Agency (USA, 1998). Costs for individual components of restoration projects are listed in Table TM2-2.

Table TM2-2. Costs for Individual Riparian Restoration Activities[1,2]

Activity	Unit	Cost
Erosion control/site preparation	Linear ft.	$2.00
Dewatering	Day	$120.00
Selective vegetation removal, disposal	sq. ft.	$1.00
Stripping of grass	sq. ft.	$0.50
Sediment removal	cubic yd.	$17.00
Grading	sq. ft.	$1.00
Earthwork (load, haul, place, compact)	cubic yd.	$20.00
Rock and rock placement	cubic yd.	$39.00
Coir/jute fabric and placement	sq. ft.	$2.00
Plant material and revegetation	sq. ft.	$1.00
Log snags/pilings and placement[3]	Each	$2,000.00
Construction administration/inspection	% of cost	2

[1]Table TM2-2 includes construction materials and labor.
[2]Adapted from USA, 1998
[3]Smith, 2000

Cost of trees to be planted along the stream was estimated as $400 per 100 linear feet.

Costs for vegetative establishment of grass and ground cover were estimated as $800 per acre.

Costs for clearing, grading, and revegetation with native species was estimated as $3,000 per 100 lineal feet of stream.

Costs for bank stabilization was estimated as $7,000 per 100 lineal feet of stream.

Costs for streambank excavation and revegetation with native species was estimated to be $20,000 per 100 lineal feet of stream.

Adjustments. Costs were multiplied by a factor of 2 to 3 for riparian enhancement with difficult access, including highly urbanized areas. Project costs were increased by 25 percent if diversion of perennial stream was required. Project costs were increased by 10 percent for work in streams that would require extra permitting because of the Endangered Species Act.

4.0 ANNUAL MAINTENANCE COSTS

Annual maintenance costs were estimated as a percentage of the construction cost for most of the engineered structures, as presented in Table TM2-3. Maintenance of miscellaneous riparian restoration projects was assumed to be 5 percent of the project cost.

Table TM2-3. Costs for Engineered Structures[1]

Type of structure	Annual maintenance as percent of construction cost
Detention pond	1
Constructed wetland	3-6
Grassed swale	5-7
Infiltration trench	5-20
Sand filter	11-13

[1]Table adapted from EPA, 1999.

5.0 PERSONNEL COSTS

Some recommended activities involved mainly personnel costs. The assumed hourly or daily costs for these activities are listed in Table TM2-4.

Table TM2-4. Personnel Costs

Activity	Unit	Cost
Coordination or field inspection	hour	$50
Engineering	hour	$70
Surveying (2 person crew)	hour	$100
Maintenance of channels and pipes (crew and equipment)	day	$1,100

6.0 REFERENCES

Beaverton, 1994. Beaverton Drainage Master Plan.

BES, 1998. Technical Memorandum 10.1. Basis for Cost Estimates, Public Facilities Plan. Bureau of Environmental Services, City of Portland

Brown, W. and T. Schueler. 1997. The Economics of Storm Water BMPs in the Mid-Atlantic Region, Center for Watershed Protection. Ellicott City, MD.

Center for Watershed Protection, 1997. Technical Note 90. The Economics of Stormwater BMPs: An Update. In Watershed Protection Techniques, June 1997.

EPA, 1999. Preliminary Data Summary of Urban Storm Water Best Management Practices. EPA 821-R-99-012.

Smith, K. 2000. Personal Communication on Unified Sewerage Agency Costs.

USA, 1997. Fanno Creek Watershed Management Plan.

USA, 1998. Technical Memorandum No. 3: Basis for Project Costs.

US Army Corps of Engineers, 1993. Flood Proofing: How to Evaluate Your Options, by the National Floodproofing Committee.

APPENDIX E
TECHNICAL MEMORANDUM NO. 3

Potential Best Management Practices for Stormwater

TO: BRUCE MOSER, PROJECT MANAGER, CITY OF CORVALLIS

FROM: JAMES HANSEN, PROJECT MANAGER

DATE: OCTOBER 19, 2000

PREPARED BY: DAVE FELSTUL, BROWN AND CALDWELL

REVIEWED BY: JAMES HANSEN, BROWN AND CALDWELL

SUBJECT: POTENTIAL BEST MANAGEMENT PRACTICES FOR STORMWATER

PROJECT: CORVALLIS STORMWATER MASTER PLAN

CONTENTS

Purpose

The purpose of this technical memorandum is to identify and briefly describe Best Management Practices (BMPs) that can be used in the Corvallis area to reduce the volume or improve the quality of stormwater runoff. The BMPs are grouped according to their position in the watershed: upstream, inline (middle), or downstream. Each section contains a summary table that lists the type of BMP, its effect on peak flows, its effect on water quality, and comments on usage.

A summary table containing details of estimated pollutant removal effectiveness and costs is included as Table TM3-4. This table includes an estimate of cost per mass of pollutant removed. The relative pollutant removal effectiveness largely follows the cost of removal per impervious acre, but is not as widely applicable, hence the use of the latter in the narrative.

Upstream Flow and Quality Controls

Upstream flow and quality controls (upstream controls) are the first line of defense for stormwater flow and quality concerns. They include techniques that delay or reduce the volume of runoff and remove pollutants before they enter the conveyance system. Reducing peak flows is especially important in Corvallis because of the need to restore more natural stream flows due to fisheries concerns. Pollution prevention with upstream controls tends to be less expensive than using inline or downstream controls. Table TM3-1 contains a summary of upstream controls.

Most of the BMPs listed in Table TM3-1 are commonly referred to as "structural BMPs." This classification of BMPs requires the construction or purchase of the treatment facility. Non-structural BMPs include street sweeping and pollution reduction actions designed primarily to prevent pollution through good housekeeping measures.

Table TM3-1. Summary of Upstream Controls

Method	Peak flow reduction	Quality improvement	Applicability/Comments
U1) Roof-top catchment	Yes, 50 percent reduction in runoff volume from roof, 10 percent reduction in peak	Minimal	Flat commercial roofs
U2) Isolation of roof drains from collection systems	Yes, total flow reduction depends on ability to percolate or store water	Minimal	Residential areas with permeable soils
U3) Infiltration	Yes, both peak and total, 100 percent	Yes, soil aquifer treatment	Need permeable soils, goes with roof drain isolation
U4) Porous pavement and concrete grid/modular pavement	Peak reduction	Yes	Susceptible to clogging, needs permeable soil.
U5) Revegetation	Yes, both peak and total	Yes	Need to remove pave-ment
U6) Vegetated swales	Some attenuation	Yes	Mild slopes
U7) Vegetated filter strips	Some attenuation	Yes	Mild slopes
U8) Street sweeping	No	Yes	Vacuum/sweepers are best
U9) Pollutant reduction (non-structural BMPs)	No	Yes, pollution prevention	Good housekeeping
U10) Catch basins	Minimal	Yes	Requires maintenance
U11) Inlet/catch basin inserts	No	Yes	Requires frequent cleaning
U12) Oil/water separators	No	Yes	Industrial and commer-cial areas
U13) Sedimentation structures and ponds	Yes	Yes	Flat areas, also used for downstream treatment

U1) Roof-Top Catchment [22, 31]. This BMP stores rainfall on rooftops. Storage through establishment of a roof-top garden is known as an eco-roof. Eco-roofs have been successfully used in many European communities. They provide a significant reduction in peak flow and volume of runoff through storage and evapotranspiration which limits the stress on the stormwater and combined sewer conveyance systems. Selecting appropriate plants for the roof that are resistant to temperature and precipitation extremes, such as sedum, a hardy, low-growing succulent, helps minimize maintenance efforts.

Studies have found that eco-roofs lower maintenance costs by providing improved insulation characteristics and lengthening the roof's life expectancy to 36 years, as opposed to 12 years for a conventional commercial roof. These benefits are the result of the increased thermal mass of the roof which limits the expansion/contraction cycle. (The following website, www.roofmeadows.com/index.htm, contains additional information as well as pictures.)

Siting. Siting is dependent on roof configuration, rather than on topography. Design limitations include the load-bearing capacity of roofs (an eco-roof will add at least 15 pounds per square foot), the pitch of the roof (pitches up to 50 degrees have been reported), and the ability of the roof to resist leaks with longer exposure to wet conditions. This BMP is best used on large commercial or industrial roofs. It is logistically more difficult to use eco-roofs on single-family residences, which also tend to have steeper pitch. Eco-roofs can be used to retrofit existing buildings where loadings are acceptable (such as roofs that already trap water for thermal mass). However, in many cases, it will be easier to use eco-roofs with new buildings.

Costs. dollars/impervious acre: high. Eco-roofs cost more to construct than conventional roofs, but result in a net saving over the roof's life span. An eco-roof with vegetation appropriate to the climate should require little or no irrigation, fertilization, or mowing after it is established (2 years or less).

U2) Isolation of Roof Drains from Collection Systems [12, 19, 29]. Roof drains may be separated from pipes and gutters and redirected through channels or into infiltration facilities. Disconnecting roof drains from the collection system allows for treatment and reduces the peak and volume of flows.

Drainage from commercial and industrial applications tends to be more polluted than that of residential areas. Therefore, only residential roof drain disconnects are usually considered for this measure. Disconnects may not be cost effective in homes with internal roof drains due to the difficulty of disconnecting these drains. The flow from roof drains has to either be infiltrated on the property or be connected to a separate storm sewer system. Infiltration possibilities may be limited in areas with bedrock close to the surface, in areas with a high groundwater table, or in areas with very impervious soils.

Siting. This BMP is best used in areas where infiltration can be used to dispose of stormwater. Downspout infiltration systems are usually assumed to need a minimum 2 feet depth of underlying permeable soils. Slopes should be less than 25 percent. A change in the building code that requires roof drains to be connected to the sewers would be required to decouple rooftop drainage from the piped collection system.

Costs. dollars/impervious acre: high. The cost per house is usually less than $500 unless new laterals are necessary. Some areas with adverse local conditions may see higher costs.

U3) Infiltration [4, 9, 10, 16, 25, 29, 36, 43]. Infiltration facilities such as trenches and infiltration basins are designed to intercept and reduce surface runoff from developed areas. These facilities hold runoff long enough to allow it to enter the underlying soil. They can include layers of coarse gravel, sand or other media to filter the runoff before it infiltrates the soil. Infiltration helps decrease peak flow and volume of runoff.

Siting. Opportunities for larger infiltration facilities are limited in areas with clay soils, steep slopes (greater than 15 percent), or where the bedrock or water table is close to the surface (less than 4 feet from the bottom of the facility), as is the case through most of Corvallis. The only sections of the city that have areas with high infiltration rates are located in the Squaw Creek watershed, the Stewart Slough area, and along the riverbanks at the junction of the Marys and Willamette Rivers. However, most of these areas experience seasonally high groundwater tables that limit the effectiveness of infiltration when it is most needed. Potential infiltration opportunities at other locations would require a site by site evaluation.

Infiltration facilities should not be sited in areas that directly recharge underground aquifers or in areas with industrial or commercial land use.

Costs. dollars/impervious acre: high. The capital cost of infiltration facilities is relatively low, in part because they require less pipe than conventional conveyance systems. However, the maintenance costs are high due to the periodic cleaning required to remove sediment.

U4) Porous Pavement and Concrete Grid/Modular Pavement [16, 36, 43]. Porous pavement is constructed with an open-graded asphalt aggregate underlain by permeable soils or fill. Modular pavement is constructed using concrete blocks with patterns, or pavers forming open spaces that may be filled with sand and/or vegetation. Porous pavement or modular pavement may be used as a substitute for conventional asphalt pavement in low-traffic areas, such as the fringes of parking lots. They are not appropriate for most streets, which use a thick base of relatively impervious material for the foundation. The use of porous pavement or modular pavement decreases runoff and pollutants by allowing infiltration into underlying soils.

Porous pavement is very susceptible to becoming clogged with fine particulates. Sand and grit application should not be used on porous pavement. Vacuuming is required to remove fine-grain soils clogging the pavement. Corvallis building codes would need to be changed to allow the use of pavers rather than concrete or asphalt.

Siting. Must be located in areas with infiltration potential (see infiltration basins above). A 6-inch permeable base is recommended under a modular grid pavement.

Costs. dollars/impervious acre: high. Concrete grid/modular pavement is more expensive than porous pavement, but requires less maintenance. (The maintenance cost of pavers shows as a negative value in Table TM3-4 because they require less maintenance than traditional pavement).

U5) Revegetation [6, 37]. Revegetation refers to conversion of paved areas to vegetated areas. An example would be to replace some of the paved surfaces in downtown sidewalks with planted trees. Revegetation provides shade, cooler temperatures, pollutant reduction, and allows for some infiltration.

Tree interception reduces the amount of stormwater run-off by 28 percent for coniferous trees and 13 percent for deciduous trees. Conifers hold water more efficiently because on conifer needles the rain droplets remain separated. On broad leaf surfaces droplets run together and roll off. The intensity, duration, and frequency of precipitation also affect the levels of interception.

Care must be taken to select hardy species for revegetation in urban areas. Dry summer weather requires drought-tolerant plants to reduce the need for watering. In areas with heavy traffic, tolerance to exhaust fumes is important.

Siting. Revegetation may be used anywhere that soil exists for plant establishment. Poor soil conditions or heavy traffic areas may require additional soil preparation and maintenance. In completely paved areas, some benefits may be realized through the use of large planters.

Costs. dollars/impervious acre: low. The cost of revegetation is relatively low, starting at about $1 per square foot. Site preparation and irrigation, if required, can add considerable cost.

U6) Vegetated Swales [5, 11, 16, 26, 32, 41, 43]. Vegetated swales, also known as biofiltration swales, are vegetated channels with a slope similar to that of standard storm drain channels (less than six percent slope), but wider and shallower to maximize flow residence time, thereby reducing peak flows and promoting pollutant removal. Although they can be designed to allow infiltration, swales in the Corvallis area would most likely be limited to biofiltration as the pollutant removal mechanism due to the low perviousness of the soils. Swales can also be used to retrofit road medians.

Siting. Vegetated swales are most appropriate on relatively gentle slopes of less than 15 percent, with a drainage area of up to 15 acres. Swales can be incorporated into development and redevelopment projects, often as an amenity. They do require a larger easement than a piped system, however. Swales may also be used in right of ways along roads, similar to ditches.

Costs. dollars/impervious acre: low.

U7) Vegetated Filter Strips [4, 16, 29, 41]. Vegetated filter strips are narrow planted areas that provide filtration of stormwater before it enters ditches or streams. They are usually installed along parking lots and are often planted with grass. Their relatively narrow width allows placement in areas with limited space. They are designed to convey overland sheet flow and do not handle concentrated flows very well. Their use in areas with steep slopes is limited.

Siting. Slopes should be less than 5 percent, but with care, filter strips can work on slopes up to 15 percent.

Costs. dollars/impervious acre: low. The need to inspect and protect against channelized flows adds to maintenance costs.

U8) Street Sweeping [7, 34]. Sweeping removes debris and particulates from paved surfaces; it does not decrease the peak or volume of stormwater runoff. The pollutant removal effectiveness is dependent on the sweeper technology and frequency of cleaning. Street sweepers usually have a rotating brush, but may also have a vacuum, or jets for washing. Street sweeping technology has improved considerably over the last ten to twenty years; older models are not as effective as the newer ones. Sweeping is one of the best methods for removing stormwater pollutants in urban areas. This source control type of activity removes pollutants before the runoff enters the storm-water collection system or streams.

Restrictions on street sweeper operation are primarily due to traffic patterns and costs. For instance, state highway departments may be restricted by the amount of time that lanes can be blocked on highways for street sweeping. On residential streets, clearing the street of parked vehicles can also be difficult. Street sweepers require a high capital investment, thus limiting the number of sweepers available to a community.

Siting. Sweeping may be used on any paved area.

Costs. dollars/impervious acre: low. Street sweepers are a big ticket item to purchase ($150,000 to $250,000), but have only moderate operation and maintenance cost. Operational costs are dependent on frequency of use. Figure TM3-1 shows how sediment removal efficiency is related to the frequency of sweeping. Removal efficiency continues to improve with more frequent sweeping, with the maximum efficiency point lying between weekly and monthly sweeping. Increasing the frequency beyond once per week provides limited additional benefit.

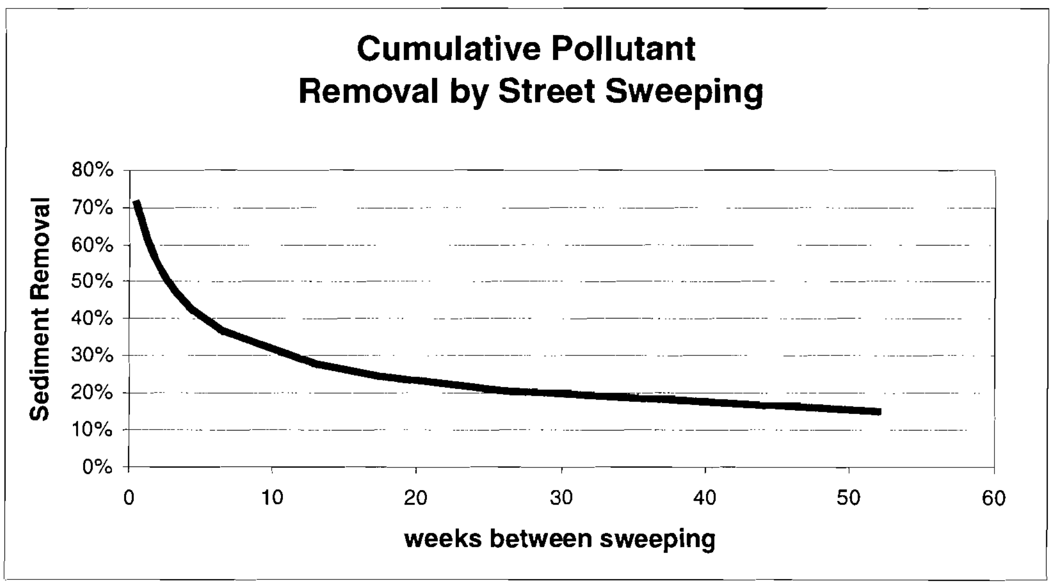


Figure TM3-1. Pollutant Removal Efficiency versus Sweeping Frequency of Street Sweepers [34]

U9) Pollutant Reduction (Non-structural BMPs). In addition to the many structural BMPs that may used to reduce the pollutants found in stormwater, there are a large number of non-structural activities that are also effective. These are often referred to as "good housekeeping" measures. Most of these activities fall into categories such as preventing the exposure of materials to rain (covering), preventing spills from entering the conveyance system (containment), and general good housekeeping measures. Non-structural BMPs may be implemented in several ways. For example, ordinances may be used to control the application of pesticides and herbicides. Public education may teach proper use of household chemicals including fertilizers. Spill prevention planning can be used to reduce problems caused by large spills of chemicals.

Most non-structural methods are not designed to decrease the rate of stormwater runoff, but to limit pollution. Their effectiveness varies widely and is difficult to quantify with any accuracy.

Siting. No siting constraints.

Costs. dollars/impervious acre: NA. The cost of most non-structural methods varies, but is relatively, inexpensive compared to structural methods.

U10) Catch Basins [4, 5, 7, 11, 23, 32, 43]. Catch basins may be designed with or without a bottom compartment that is designed to trap particulates. Without the trap, the catch basin does not remove any pollutants, and requires little maintenance. With the trap and regular cleaning, the catch basin will remove coarser particulates. Catch basins may also be constructed to trap oils and floatable trash. A drop inlet catch basin has a goose-necked outlet pipe that maintains a semi-permanent pool, trapping floatables, oils, and coarse solids.

A number of catch basin inserts are available on the market. They are designed to improve pollutant removal by inserting a series of trays, absorbent material, or filters between the catch basin inlet and the outlet pipe (see BMP U11 for details).

Siting. Catch basins are an integral part of Corvallis' conveyance system. Each catch basin typically has only a small contributory drainage area, 1/8 acre or so, when all of the City of Corvallis' (City) catch basins are considered, the overall impact of catch basins can be significant.

Costs. dollars/impervious acre: low. The cost per catch basin is relatively low, but each catch basin treats only a small drainage area, so the capital cost of the entire drainage system may be high. The operational costs are largely dependent on the frequency of cleaning. Figure TM3-2 shows that a cleaning frequency of between 6 and 9 months is probably ideal for most catch basins, although less frequent cleanings will also help. The City cleans its catch basins every year in high-traffic and leaf litter sites and every other year for other sites.

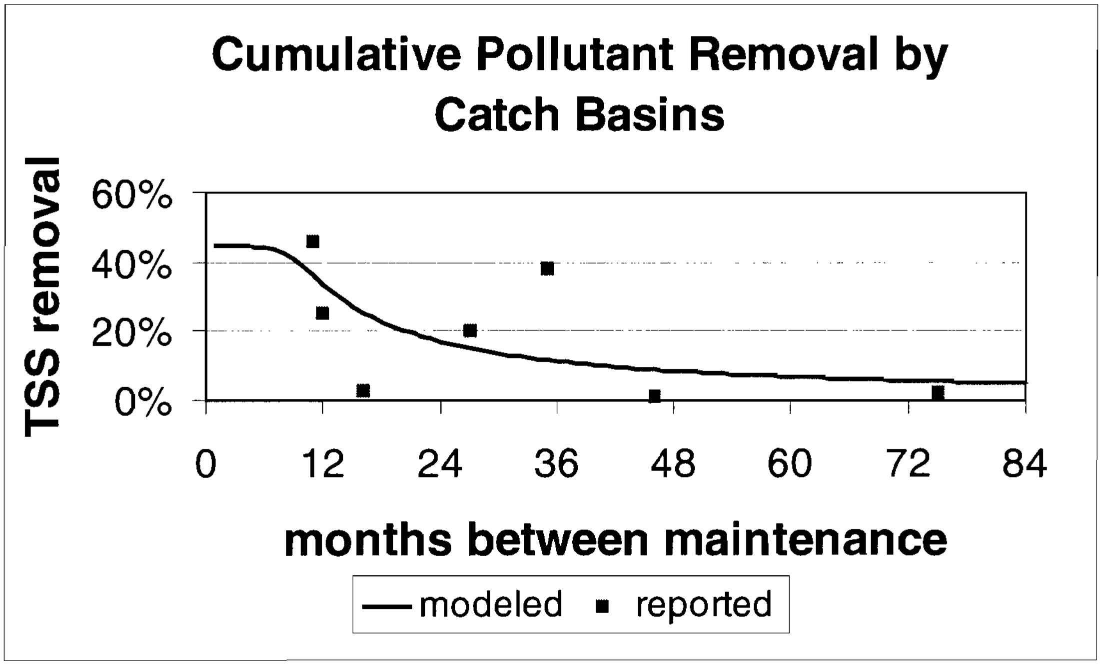


Figure TM3-2. Catch Basin Pollutant Removal versus Cleaning Frequency [7, 23]

U11) Inlet/Catch Basin Inserts [15, 27, 29, 30]. Inlet/catch basin inserts are devices that are placed within a stormwater inlet or catch basin to trap pollutants. The most common type is a fabric liner or sock. A more complex device is an arrangement of trays that have wells for sediment removal and high flow bypass capability. Field testing of inserts has shown varying degrees of effectiveness. In general, rigid inserts allow the washing out of particulates after a few storms. Fabric inserts are more effective at trapping particulates, but are usually temporary in nature and require more frequent maintenance.

Siting. Can be used with any standard configuration of inlet.

Costs. dollars/impervious acre: high. Inlet/catch basin inserts require frequent inspection and maintenance.

U12) Oil/Water Separators [16, 18, 36, 43]. Oil/water separators are multi-chambered devices that are designed to remove hydrocarbons from stormwater runoff as water flows through. Three main variations exist: spill control separators, American Petroleum Institute (API) separators, and coalescing plate separators. Spill control separators are the cheapest and least complex of the three. They consist of a simple underground vault or manhole with a "T" outlet designed to trap small spills. American Petroleum Institute separators are long vaults with baffles designed to remove sediment and hydrocarbons from urban runoff. Coalescing plate separators include a series of parallel inclined plates which encourage the separation of materials of different densities. The plates are typically made of fiberglass or polypropylene and are closely spaced to improve the hydraulic conditions in the separator and promote oil removal.

These devices can be used under a wide variety of physical conditions. They need to be placed underground, and are limited to treating runoff from small areas since low flow velocities are required to achieve treatment efficiencies.

Oil/water separators do not reduce peak flows or the volume of runoff. They can be effective at removing oil and grease and floatable trash, but are ineffective at removing fine particulates and soluble pollutants.

Siting. Slopes less than 15 percent and drainage areas less than 1 acre are suitable. Separators are sized according to runoff velocity and volume.

Costs. dollars/impervious acre: high. Purchase costs are high, but maintenance costs are low.

U13) Sedimentation Structures and Ponds [5, 29, 32, 43]. Extended detention ponds are the best example of this type of BMP. The ponds are earthen structures designed to retain water or they may be an open concrete vault designed for easy sediment removal by heavy equipment.

Siting. Slopes should be less than 10 percent. Drainage area is usually less than 10 acres.

Costs. dollars/impervious acre: medium. As with other surface structures, sedimentation ponds are often limited by the availability and cost of land.

Inline Flow and Quality Control

Inline controls are those that act on stormwater that has entered the conveyance system. They are all structural in nature and tend to be more dispersed and smaller than the downstream controls. In highly developed areas, most inline controls are located underground. Table TM3-2 contains a summary of inline controls.

Table TM3-2. Summary of Inline Controls

Method		Peak and total volume reduction	Quality improvement	Applicability/comments
I1)	Vortex solids separation (hydrodynamic)	Minimal	Yes, depends on design and type	Also downstream treatment, good for floatables removal and settleable solids
I2)	Wet tank vault	Minimal	Yes	Washout is a problem
I3)	Sand filters	No	Yes	Also downstream control
I4)	Other filtration media	No	Yes	Also downstream control
I5)	Vortex valves and hydrocarbons	Peak flows only	No	Flow attenuation
I6)	Detention ponds	Yes, beak reduction	Yes, good pollutant removal	Need large flat area for siting

I1) Vortex Solids Separation (Hydrodynamic) [1, 2, 17, 39]. This type of device works by directing incoming water at an angle to create a vortex. The vortex directs coarser particulates toward the center where they are either stored at the bottom or removed by an underdrain for further treatment. Vortex solids separation is most effective when used with systems that have high solids loading, such as combined sewer systems. It is less effective when used with stormwater, which typically has smaller solids concentrations. However, only limited data is available from tests of these devices in the field.

> ***Siting.*** Facility size is dependent on flow. The smallest unit is about the size of a standard manhole. Siting requires adequate depth to accommodate the size of unit.
>
> ***Costs.*** dollars/impervious acre: medium.

I2) Wet Vault Tank [14, 18]. Wet vault tanks are underground tanks with baffled chambers that contain a standing pool of water. They are larger in size than most oil/water segregators, but act according to the same physical principles. They temporarily retain a portion of the stormwater runoff and remove solids by settling, and, depending on configuration, biological activity. Like most vaults, sediment washout from the previous event can be a problem if the vault is not properly designed, and during periods of dry weather, maintaining a wet pool for enhanced treatment is difficult.

Recently, Brevard County, Florida, has reported success with baffled boxes, a type of wet vault, to provide an end of pipe treatment method for up to 100 acres of drainage. These baffled boxes are constructed in line and are divided into 2 or 3 chambers by weirs. To minimize hydraulic losses, the weirs are set at the same level as the pipe invert. Trash screens or skimmers are included to trap floating debris.

> ***Siting.*** Siting information is given for the traditional style of wet vaults. Wet vaults require slopes of less than 15 percent. They typically treat drainage areas of up to 5 acres.
>
> ***Costs.*** dollars/impervious acre: low.

I3) Sand Filters [2, 8, 10, 18, 38]. Sand filters are devices that filter stormwater runoff through a sand layer into an underdrain discharge system. The underdrain conveys the treated runoff to a detention facility or to the ultimate point of discharge. A number of variations of sand filters have been developed, open units and those constructed in vaults. They generally consist of an inlet structure, sedimentation chamber, sand bed, underdrain piping, and liner to protect against infiltration.

The most typical configuration for a highly urbanized area is a sand filter contained in a vault. They are applicable to a wide variety of conditions. Like most filtration devices, they treat relatively small areas and require pretreatment in areas with high solids loadings to avoid media clogging.

Sand filters do not reduce peak flows or volumes of runoff. However, they are effective at removing most pollutants, although less effective for dissolved pollutants.

Siting. Up to 10 percent slope and 5 acres.

Costs. dollars/impervious acre: high. Capital cost is moderate, but sand filters tend to be maintenance-intensive due to their tendency to become clogged.

I4) Other Filtration Media [2, 5, 7, 11, 29]. Filtration may be achieved with media other than sand, including compost material or iron compounds. The device operates in a similar manner to a sand filter, but the configuration may be more complex. For example, the compost filter systems take the form of bales or cartridges, allowing easy replacement when they become clogged. Like sand filters, filtration with other media does not decrease peak flow or volume of runoff. Filtration with organic media, such as compost, is one of the better BMPs for removing dissolved metals. On the other hand, organic media have a tendency to add dissolved nutrients to runoff. Some recent work suggests that filtration with iron compounds may be effective in removing nutrients, but more field tests are needed.

Siting. Filtration media facilities generally serve 5 acres or less. Like other underground facilities, filtration facilities need adequate depth above the bedrock/water table.

Costs. dollars/impervious acre: medium.

I5) Vortex Valves and Hydrobrakes (various configurations) [19, 20, 40]. Vortex valves and hydrobrakes are devices which use vortex motion to restrict flow. Examples include Steinscrew, hydrobrake, wirbeldrossel, and flow valves. Passage is unrestricted at low flow rates. As flow rates increase, passage become restricted as a vortex is created by an orifice structure. As flow rates continue to increase, eventually the vortex breaks down and the normal full pipe capacity is utilized. They are often used to slow flows into the piped conveyance system by creating a pond of stormwater behind the flow restrictor, either on the surface or in the piped conveyance system. Vortex valves require less operation and maintenance effort than other flow control systems due to a lack of moving parts and control systems. They also pass a relatively constant flow rate, which aids in the operation of treatment facilities downstream.

Siting. If water is to be stored on the surface or in streets, relatively flat areas are required. The siting of vortex valves requires engineering/modeling analysis to determine where flows can be restricted without causing flood damage or damage to roadways.

Costs. dollars/impervious acre: NA. Installation into existing pipe is easy and it does not require frequent maintenance.

I6) Detention Ponds [4, 7, 9, 10, 16, 24, 36]. Ponds are one of the oldest and most effective methods of solving both flooding and water quality problems. Detention ponds are constructed to decrease flooding by lowering peak flows. (Water quality ponds are discussed as part of BMP D1.) They store runoff in an excavated or bermed basin with discharge controlled through an outlet pipe or orifice. Detention solely for flood control allows water to be impounded for much shorter periods of time, usually 24 hours or less, and does not require a permanent pool of water.

Ponds have several drawbacks: they require a large surface area, they can increase the temperature of stored water, and they may be a safety hazard. Increases in stormwater temperature may create problems where there are discharges into channels with temperature restrictions. Use of ponds in Corvallis is limited mainly because of lack of open space. Fencing may be required to address safety issues.

Siting. May be sited on slopes up to 10 percent. They can be sized to treat very large areas, but space limitation usually limits the drainage area to 20 acres or less.

Costs. dollars/impervious acre: medium. As with other surface structures, detention ponds are often limited by availability and cost of land. However, they are usually designed to minimize maintenance requirements, with up to 20 years between sediment removal.

Downstream Flow and Quality Controls

Downstream flow and quality controls (down stream controls) are located at the bottom of the drainage system. They manage higher flows and higher pollutant loads than upstream or inline controls. Downstream facilities tend to have high capital costs, due in part to their large size. But if costs are based on the number of impervious acres, downstream facilities are often quite competitive. Table TM3-3 contains a summary of downstream controls.

Table TM3-3. Summary of Downstream Controls

Method	Peak and total volume reduction	Quality improvement	Applicability/ comments
D1) Constructed wetlands and water quality ponds	Yes, peak reduction	Yes, good pollutant removal	Need large flat area for siting
D2) Fine screens	No	Yes, floatable reduction	A CDS unit has been installed in Eugene

D1) Constructed Wetlands and Water Quality Ponds [4, 10, 11, 16, 24, 36, 43]. Constructed wetlands and water quality ponds operate in much the same manner. They provide effective, long-lasting stormwater treatment. They require more space than many of the other techniques, which limits their application in fully-developed areas. Desirable wetland vegetation may be adversely affected by large changes in the water surface experienced between dry and wet seasons. Increases in stormwater temperature may be a concern with impounded water, especially when discharging into channels with temperature concerns or regulatory limits. Wetlands differ from ponds in that they are shallower, which allows more vegetation to grow. Wetlands provide greater habitat benefits than ponds and their pollutant removal effectiveness may be slightly greater.

Siting. Limited to flat areas, slopes of 5 percent or less. Can be used with drainages of up to 50 acres or more, but the size of wetlands usually becomes prohibitive in terms of land requirements. The catchment ratio is the ratio of the pond's surface area to the drainage area. The catchment ratio needs to be a minimum of 0.5 to 1.0 percent to be effective, and 1.5 percent for shallow wetlands (greater than 3 feet depth). Figure TM3-3 shows the sediment removal effectiveness of different sized ponds. The three lines in the graph represent different runoff coefficients. According to the chart, a 3-foot deep pond covering 1 percent of a drainage area with a runoff coefficient of 0.50, would remove about 75 percent of incoming suspended solids.

Costs. dollars/impervious acre: medium. As with other surface structures, wetlands are often limited by the availability and cost of land.

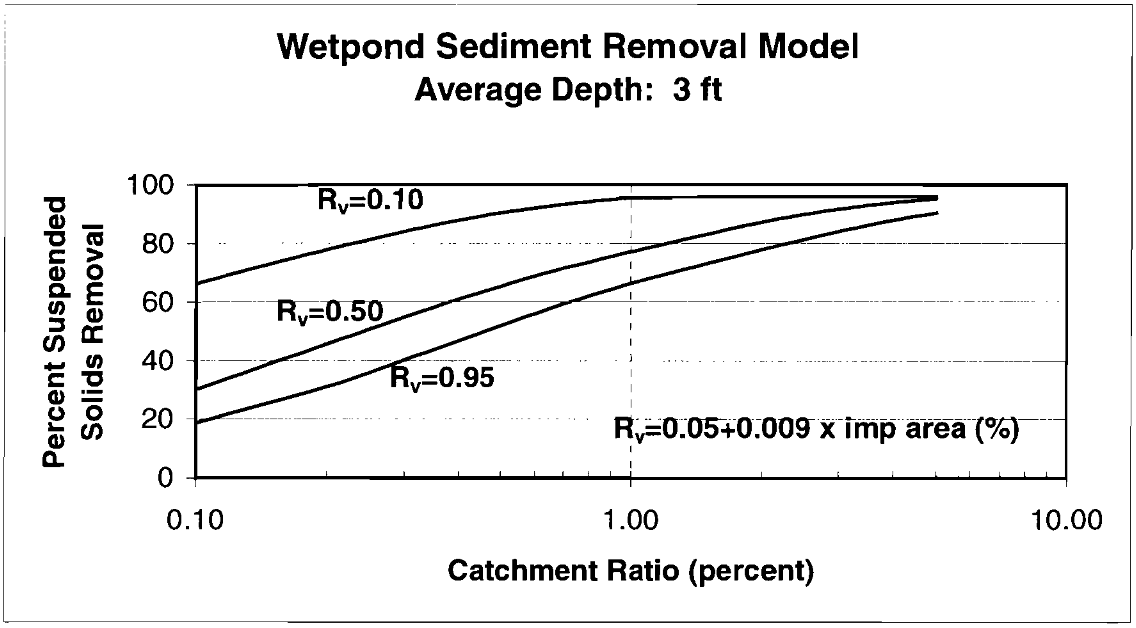


Figure TM3-3. Sediment Removal Effectiveness of Different Sized Ponds

D2) Fine Screens [17, 33, 42]. An example of the use of fine screens for CSO/stormwater treatment is a proprietary device called a Continuous Deflective Separator (CDS) system. A CDS is installed underground in a storm or combined sewer line. Like a vortex swirl concentrator, flows enter at an angle, swirling around and concentrating coarse particulates and floatables in the center. The CDS adds a fine screen on the outside of this swirling action, which deflects smaller particulates out of the water before it exits the device through the screen. Adsorbent material can be added to the center of the device to remove oil and grease.

Siting. Siting concerns are similar to those for vortex solids separators. The typical size is about that of a manhole, but when used as a downstream measure, it will need to be larger. Requirements include adequate depth to bedrock, which is dependent on drainage area and size of unit.

Costs. dollars/impervious acre: low.

Comparison of BMP Cost and Effectiveness

All of the management measures discussed above are included in Table TM3-4. The table includes columns that show pollutant removal (percent Total Suspended Solids removal) and flood control. Capital costs, operations and maintenance costs, and expected facility life are shown and then combined to give the annual cost of the facility. By estimating the area served by the facility and the incoming pollutant load, the cost per impervious acre and cost per pound of sediment removed were calculated.

The estimates of cost and facility effectiveness in Table TM3-4 are based on many assumptions of both facility configuration and drainage characteristics. As much as possible, facility configurations were based on the most common application of that type of facility. Actual facility types will vary in size, configuration, and operational characteristics. Facility effectiveness was calculated from pollutant removal models and based on the literature sources. The literature is presented in the Reference Section.

The high, medium, and low ranges for the cost per impervious area and per pound of pollutant removed shown at the bottom of the table were used to derive the costs in the narrative.

Table TM3-4. Stormwater BMP Comparative Cost and Effectiveness

	Reported efficiency		Total capital cost ($)	Annual O&M cost ($)	Expected life (years)	Annual cost $/facility	Equivalent annual cost $/impervious acre	Treatment efficiency $/lb pollutant removed	Data sources
	% TSS removal	Flood control							
Upstream Flow and Quality Control									
Rooftop catchment (eco-roof), per acre of roof	0	yes	261,360	0	36	7,260	7,260	NA	22, 31
Isolation of roof drains from collection system	0	yes	1,900	0	20	95	2,759	NA	12, 19, 29
Infiltration	80	yes	10,164	1,098	10	2,114	3,020	8.33	4, 9, 10, 16, 25, 29, 36, 43
Porous paving, per acre	90	yes	108,900	523	10	11,413	11,413	27.99	16, 36
Concrete grid/modular pavement, per acre	90	yes	226,512	-2,091	20	9,235	9,235	22.65	16, 43
Revegetation, per acre	50	yes	800	139	10	219	313	1.38	6
Vegetated swales	60	yes	20,000	139	50	539	77	0.28	5, 11, 16, 26, 32, 41, 43
Vegetated filter strips	65	no	400	100	20	120	171	0.58	4, 16, 29, 40
Street sweeping with recent technology, per sweeper	75	no	200,000	455,800	20	465,800	51	0.31	7, 34
Pollutant reduction (good "housekeeping" measures)	NA	no	NA	NA	NA	NA	NA	NA	

NA = Not Available
Note: Costs do not include land acquisition

L < $300/ac	L<$2/lb
M=$300-$1500/ac	M=$2-$10/lb
H=>$1500/ac	H>$10/lb

Table TM3-4. Stormwater BMP Comparative Cost and Effectiveness (continued)

	Reported efficiency		Total capital cost ($)	Annual O&M cost ($)	Expected life (years)	Annual cost $/facility	Equivalent annual cost $/impervious acre	Treatment efficiency $/lb pollutant removed	Data sources
	% TSS removal	Flood control							
Catch basin (trapped, no inserts)	45	no	2,000	15	50	55	220	1.08	4, 5, 7, 11, 23, 32, 43
Inlet/catch basin inserts	22	no	2,400	36	5	516	2,064	20.71	15, 27, 29, 30
Oil/water separators	15	no	21,600	24	50	456	456	6.71	16, 18, 36, 43
Sedimentation structures (extended detention)	45	yes	32,243	1,290	10	4,514	645	3.16	5, 29, 32, 43
Inline Flow and Quality Control									
Vortex solids separation	52	no	5,000	250	25	450	643	2.73	1, 2, 17, 39
Wet vault tank	30	no	4,000	60	15	327	47	0.34	14, 18
Sand filters	80	no	152,460	10,672	25	16,771	2,396	6.61	2, 8, 10, 18, 38
Other filtration media (compost filter)	80	no	39,000	2,500	20	4,450	890	2.46	2, 5, 7, 11, 29
Vortex valves	0	yes	1,000	15	50	35	NA	NA	19 ,20, 40
Detention ponds	60	yes	36,554	2,000	20	3,828	547	2.01	4, 7, 9, 10, 16, 24, 36
Downstream Flow and Quality Control									
Constructed wetlands	80	yes	9,504	5,203	10	6,154	879	2.43	4, 10, 13, 16, 24, 36, 43
Fine screens (CDS)	52	no	55,000	400	25	2,600	60	0.25	17, 33, 42

NA = Not Available
Note: Costs do not include land acquisition

L < $300/ac
M=$300-$1500/ac
H=>$1500/ac

L<$2/lb
M=$2-$10/lb
H>$10/lb

References

1. Allen, V.P. 1998. Field Testing, Phase 1: Results from the Vortechs Stormwater Treatment System Monitoring Program at DeLorme Publishing Company, Yarmouth, Maine. Vortechnics website.

2. Bell, W. "Appropriate BMP Technologies for Ultra-Urban Applications," 1998 Virginia Engineers' Conference, September 17-19, 1998.

3. Brosseau, Geoff, Olivia Chen Consultants, and Brighter Image. 1998. "1997-98 Storm Water Pollution Prevention Program Final Report" San Francisco Public Utilities Commission, Bureau of Environmental Regulations and Management. June.

4. Brown and Caldwell. 1991. Surface Water Quality Facilities Technical Guidance Handbook. Prepared for Portland, Lake Oswego, Clackamas County, and Unified Sewerage Agency.

5. Brown and Caldwell. 1997. Handbook of Valley County Stormwater Best Management Practices. Prepared for Idaho Department of Environmental Quality.

6. Brown and Caldwell. 1999. Beaverton Creek Watershed Management Plan, TM No. 3. Prepared for the Unified Sewerage Agency, Oregon.

7. Brown and Caldwell. 1999. USA Surface Water Management Plan Update, TM No. 1.2: Existing Program Water Quality Effectiveness. Prepared for the Unified Sewerage Agency, Oregon.

8. Center for Watershed Protection. "Developments in Sand Filter Technology to Improve Stormwater Runoff Quality." Watershed Protection Techniques, Summer 1994.

9. Center for Watershed Protection. "The Economics of Stormwater BMPs: An Update." Watershed Protection Techniques-Technical Note 90, Vol. 2, No. 4 June 1997.

10. Center for Watershed Protection. 1997. National Pollutant Removal Performance Database for Stormwater BMPs. Prepared for Chesapeake Research Consortium, Edgewater, Maryland.

11. Center for Watershed Protection. 1998. Maryland Stormwater Design Manual Volumes I & II, Review Draft. Prepared for the Maryland Department of the Environment.

12. CH2M-HILL/Brown and Caldwell. 1993. CSO Management Program, Phase 2 Technical Memorandum 6.5, Cornerstone Projects. Prepared for Bureau of Environmental Services, City of Portland, Oregon.

13. Crites, Ron. 1999. Personal communication, Brown and Caldwell.

14. England, G. 1999. Baffle Boxes and Inlet Devices for Stormwater BMPs. Stormwater Resources website.

15. EnviroDrain filtration system website, members.aa.net/~filters/.

16. EPA. 1993. Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters. EPA 840-B-92-002.

17. EPA. 1999. Storm Water Technology Fact Sheet: Hydrodynamic Separators. EPA 832-F-99-017.

18. EPA. 1999. Storm Water Technology Fact Sheet: Water Quality Inlets. EPA 832-F-99-029.

19. EPA. 1999. Combined Sewer Overflow Technology Fact Sheet: Inflow Reduction. EPA 832-F-99-035.

20. EPA. 1999. Combined Sewer Overflow Technology Fact Sheet: Maximization of In-line Storage. EPA 832-F-99-036.

21. EPA. 1999. Wastewater Technology Fact Sheet: Ultraviolet Disinfection. EPA 832-F-99-064

22. Erisco Bauder. 1999. Green Roof System. Erisco Bauder website.

23. Felstul, D.R. "Optimization of Maintenance for Stormwater Facilities to Enhance Performance," Proceedings of the Water Environment Federation 68th Annual Conference and Exposition. Miami Beach, Florida. October 21-25, 1995. pp. 63-73.

24. Felstul, D.R. and J.M. Montgomery. "Modeling the Reduction of Sediment-bound Toxics by Detention Basins," Aquatic Toxicology and Risk Assessment, Fourteenth Volume. (M. Mayes and M. Barron, eds.); American Society for Testing and Materials, Philadelphia, 1991, pp. 294-304.

25. Ferguson, B.K. 1994. Stormwater Infiltration. Lewis Publishers: Ann Arbor, Michigan.

26. Horner, R. 1992. Biofiltration Swale Performance, Recommendations, and Design Considerations. Prepared for City of Seattle.

27. Interagency Catch Basin Insert Committee. 1995. Evaluation of Commercially-Available Catch Basin Inserts for the Treatment of Stormwater Runoff from Developed Sites. Prepared for King County Surface Water Management Division, King County Department of Metropolitan Services, Snohomish County Surface Water Management Division, Seattle Drainage and Wastewater Utility, and Port of Seattle.

28. Murray, David. 1999. Personal communication, Brown and Caldwell.

29. Oregon Department of Environmental Quality. 1998. DEQ Storm Water Management Guidelines. Oregon DEQ website.

30. Pitt, Robert. New Critical Source Area Controls in the SLAMM Stormwater Quality Model; presented at the Assessing the Cumulative Impacts of Watershed Development on Aquatic Ecosystems and Water Quality Conference, March 1996.

31. Roofscapes. 1999. Roofmeadows, Green Technology for the Urban Environment. Roofscapes website.

32. Stormwater Best Management Practices, City of Boise, Public Works Department.

33. Strynchuk, J., J. Royal, and G. England. Use of a CDS Unit for Sediment Control in Brevard County.

34. Sutherland, Roger. 1998. "How Do We Judge the Equivalency of New Treatment BMPs?"

35. Stormwater Treatment Northwest, Vol 14, No. 4.

36. Texas Nonpoint Sourcebook website, www.txnpsbook.org, sponsored by the Texas Chapter, American Public Works Association.

37. U.S.D.A.. 1998. Stream Corridor Restoration: Principles, Practices, and Processes. http://www.ntis.gov/product/stream-corridor.htm

38. U.S. Navy. 1997. Sand Filter for Treating Storm Water Runoff. Joint Service Pollution Prevention Opportunity Handbook.

39. U.S. Navy. 1997. Vortex Solids Separators for Treating Storm Water Runoff. Joint Service Pollution Prevention Opportunity Handbook.

40. Urbonas, B. and P. Stahre. 1993. Stormwater: Best Management Practices and Detention for Water Quality, Drainage, and CSO Management. PTR Prentice-Hall: Englewood Cliffs, New Jersey.

41. Walsh, P. M. 1997. Use of Vegetative Controls for Treatment of Highway Runoff, CRWR Online Report 97-5, Center for Research in Water Resources, Univ. of Texas, Austin.

42. Wong, T.H.F. 1997. Continuous Deflective Separation: Its Mechanism and Applications. Stormwater Resources website. Reprinted from 1997 WEFTEC Annual Conference Proceedings.

43. Woodward-Clyde. 1995. Stormwater Quality Facilities: A Design Guidance Manual. Prepared for the Bureau of Environmental Services Portland, Oregon.

APPENDIX F
TECHNICAL MEMORANDUM NO. 4

Recommendations to Development Standards

TECHNICAL MEMORANDUM No. 4

November 10, 1999 53-15989

TO: Bruce Moser,
City of Corvallis

FROM: James Hansen,
Brown and Caldwell

PROJECT: City of Corvallis
Recommendations to Development Standards

CONTENTS

Introduction

This technical memorandum was prepared to assist the City of Corvallis with updating of the existing stormwater development standards. The recommendations provided below should be considered as interim measures that should be implemented until a more detailed evaluation can be performed later in the stormwater master planning process. However, the interim recommendations will improve the City's ability to manage both stormwater quantity and quality from new development or redevelopment.

A more detailed analysis of the development standards should be based on citywide definition of the stormwater problems and potential solutions as determined from the master planning process. The adoption of new development standards will have a major impact on future stormwater management within the city. The standards will impact many different interest groups, including citizens, environmental groups, developers, builders, realtors, engineers, landscape architects, and city staff. City departments affected by the standards include planning, engineering, development assistance, legal, and operations/maintenance. Private and public representatives should participate in the development of the modified development standards, policies, and ordinances in order to develop an effective stormwater management program.

Major Categories of Development Standards

The major categories of stormwater development standards addressed by this technical memorandum include:

1. Design storm and method
2. Detention policy
3. Water quality policy
4. Acceptable types of water management facilities
5. Operation and maintenance requirements

The above noted categories are discussed in the following sections and are represented in the recommended design standards at the end of this document.

Design Storm and Method

Pipe sizing. The Design Criteria Manual requires the use of the Rational Method for a 10-year storm event. Most cities use either a 10-year or a 25-year design storm for sizing drainage facilities. The decision is based on the level of flood protection desired by the community along with the cost of providing the additional level of protection. Modifying the design criteria with a longer return period (i.e., 25-year) design storm would create a situation where the collection systems in the newly developed areas of the city would have greater capacity than older downstream sections of the system, thus creating greater downstream flooding situations in both open channels and pipes. We recommend that the city stay with the 10-year design storm using the Rational Method for most conveyance facilities.

We recommend that additional guidance be provided with the use of the Rational Method. The method should not be used for drainage areas larger than 25 acres or have times of concentration that exceed 100 minutes. A hydrograph technique should be used for either of these situations. Flow routes should be identified for storms larger than the 10-year, up to and including the 100-year storm. The City should adopt or establish runoff coefficients and an intensity-duration-frequency curve for use on projects within the City's jurisdiction. This approach would help provide consistency in the design of stormwater facilities.

Detention Facilities. The design storm for detention facilities should be based on the 10-year return event with 24-hour duration based on the standard SCS type 1A rainfall distribution. A hydrograph approach provides the most accurate rainfall model for this analysis. The SCS TR-55/20 method or the Santa Barbara Urban Hydrograph (SBUH) method are recommended options. We understand that most of the Corvallis development community uses the SCS method rather than the SBUH method; therefore, use the SCS method as the approved city standard. We do not recommend the use of the Rational Method for designing detention facilities.

Water Quality Facilities. The design storm for water quality facilities should be based on two-thirds of the two year storm with a 24-hour duration. This is similar to the design storm used by King County and is slightly more conservative than the storms used by City of Portland and the Unified Sewerage Agency. The more conservative approach will better prepare the city for future TMDL, NPDES Phase II and Endangered Species Act requirements. Water quality facilities should be designed using a hydrograph technique as recommended for detention facilities.

Detention Policy

The existing level of development throughout the city has altered the natural drainage characteristics of the major surface water systems. These streams are under stress due to an increase in the volume and duration of stormwater runoff. In addition, some of the older piped collection systems and culverts are becoming undersized as additional development generates increased flows and durations. Detention and other types of stormwater management techniques are required to prevent these problems from getting worse.

Water Quality Policy

Urban development creates a wide range of stormwater management related problems, including higher flow rates and increased water pollution. Surface water collects a variety of pollutants as it travels through the drainage system, including nutrients, suspended solids, organic matter, bacteria, hydrocarbons, trace metals, pesticides, thermal pollution and trash and debris. Water quality facilities constructed in new and redeveloped areas will help lessen the negative impacts associated with increased urban development.

Acceptable Types of Water Management Facilities

Our letter dated May 13, 1999 identified five facility types that should be considered for immediate use for new development or redevelopment, including detention ponds, water quality ponds, sedimentation ponds, vegetated swales, and water quality inlets. The King County Manual should be used as guidance for the basis of design of these facilities. The City should consider the adoption of the other treatment facilities identified in the manual. A toolbox of acceptable facilities would allow developers to customize the design of detention and water quality systems to best meet the constraints of the site.

The City should consider developing a guidance manual for the design of stormwater quantity and quality facilities. A custom manual would address the specific needs of the Corvallis community. A manual specifically prepared for the City of Corvallis would provide the greatest ease of use for City staff and design professionals in the community. A minimum of $75k would be required to produce such a manual. The total effort required would be dependent on the level of detail provided by the manual. Several of the manuals in use throughout the northwest cost many times that to produce.

Operation and Maintenance Requirements

Detention and water quality facilities require routine maintenance to ensure the desired performance of the facility. The efficiency of most types of water quality facilities will drop significantly in the absence of routine maintenance. The maintenance requirements identified in the King County Manual should be followed for these facilities. Inspection of major stormwater facilities, including detention ponds, water quality ponds, vegetated swales, trash racks, etc. should be conducted annually. The City should develop and manage an inspection program to ensure that the maintenance is being performed for both public and privately owned facilities. The cost of the inspection program needs to be determined and an appropriate funding mechanism established for implementing the inspection program.

Support of the inspection program needs to be written into City code. The code needs to be modified to provide for enforcement actions to address maintenance deficiencies for privately owned facilities. Using the King County model, the City would perform the maintenance and charge the owner if the owner did not perform the required maintenance within a specified timeframe.

Facility access is a major complaint of many municipalities charged with maintaining storm water facilities. Where possible an all-weather access road should be provided to the site. This requirement is particularly important for those facilities requiring routine maintenance, such as, detention and water quality facilities. The City shall ensure during design review that adequate access to the facility is provided through a maintenance easement or other form of permanent legal transfer of the right-of-access to the City.

Proposed Changes to the Design Criteria Manual

The following sections represent interim replacement or additional sections to the existing *Design Criteria Manual for Public Improvements*. The changes affect Section IV. STORM DRAINAGE. Only the subsections shown below are modified.

IV. STORM DRAINAGE

B. Design Criteria

1. <u>Conveyance Facilities</u>

   a. Capacity

      1) Conveyance facilities shall be designed to convey and contain the peak runoff flow from the 10-year design event. No surcharging of the system is allowed for the 10-year storm event. Conveyance system capacity shall be determined for most conveyance facilities using the Rational Method.

A hydrograph technique shall be used for designing facilities draining areas larger than 25 acres or for sites that have a time of concentration longer than 100 minutes. Acceptable hydrograph techniques include the Soil Conservation Service (SCS) TR-55 or TR-20 methods. The SCS Type 1A rainfall distribution for the 10-year, 24-hour storm shall be used with the hydrograph techniques.

2) The 10-year design shall be supplemented with an overland conveyance component demonstrating the safe passage of the 100-year, 24-hour SCS type 1A storm event. The overland component shall not be allowed to flow through or inundate existing buildings.

3) Sufficient capacity shall be designed into the system to account for the future growth potential of the area served as identified in the Comprehensive Plan.

b. Sizing

1) Minimum pipe size for storm drain mains is twelve (12) inches.
2) Minimum pipe size for lines leading from curb inlets or catch basins to the main lines is ten (10) inches.

c. Grades

1) All storm drains shall be designed at a grade that will produce a mean velocity when flowing full or half-full of at least two (2) feet per second.

d. Separation

1) New combined sanitary sewer and storm drain systems will only be permitted in the existing combined sewer areas of the city.

2. <u>Detention Facilities</u>

a. The maximum design storm for detention facilities shall be based on the 10-year return event with 24-hour duration based on the standard SCS Type 1A rainfall distribution. The Soil Conservation Service (SCS) TR-55 or TR-20 are recommended. The use of alternative hydrograph methods may be allowed, but require pre-approval by the City. The use of alternative techniques may require additional development review time. The use of the Rational Method for designing detention facilities is not permitted.

3. <u>Water Quality Facilities</u>

a. The design storm for water quality facilities (vegetated swales, water quality ponds, sedimentation ponds, water quality vaults, etc.) shall be based on two-thirds of the 2-year, 24-hour SCS Type 1A design storm. The analysis and design shall be based on a hydrograph method. The Soil Conservation Service (SCS) TR-55 or TR-20 are recommended. The use of alternative hydrograph methods may be allowed, but require pre-approval by the City. The use of alternative techniques may require additional development review time. The use of the Rational Method for designing water quality facilities is not permitted.

K. Detention Facilities

1. <u>When Required</u>

All new development and redevelopment shall require detention unless specifically exempted from this requirement. When required, stormwater detention facilities shall be designed to capture run-off so the run-off rates from the site after development do not exceed the predeveloped conditions, based on the 2-year through 10-year, 24-hour design storms.

2. <u>Exemptions</u>

   a. Detention is not required for sites draining directly into Mary's River or the Willamette River.

   b. Detention is not required if infiltration methods can be demonstrated to be feasible. A soil map or geotechnical report is required to document the infiltration rates of the soils in the area of the proposed infiltration facility. Infiltration shall not be allowed in areas with slopes over 10 percent.

   c. Detention is not required for single family residences not developed as part of a planned development.

   d. Detention is not required for areas specifically identified as exempt (not requiring detention) in the Corvallis Stormwater Master Plan.

3. <u>Standards</u>

   a. Detention facilities shall be designed in accordance with criteria as established in the *King County, Washington Surface Water Design Manual,* September 1998 or the most recent final version.

   b. Parking areas should not be used as detention facilities except for larger storm events. Up to 6-inches of water depth is allowed to be detained in parking areas for storm events larger than the 10 year return event.

   c. Detention of storm water shall be limited to a single facility, rather than a series of smaller detention facilities, whenever possible. Detention facilities may be designed as combination detention and water quality facilities. Detention facilities may be designed "in-line" with water quality facilities.

   d. The detention facility must be designed to safely pass storms up to the 100-year, 24-hour event.

4. Access and Maintenance Responsibility

   a. Detention facilities must be located on a site dedicated for public use. Access tracts, easements or permanent right-of-ways are required when the facilities do not abut the public right-of-way. The minimum width of an access easement is 15 feet. All-weather road(s) shall provide maintenance vehicle access to the facility and the control structures.

   b. The City will assume maintenance and operation responsibility for detention facilities within the improved public right-of-way for any residential subdivision with two or more lots, and any similar development or redevelopment where at least two-thirds of the developed contributing area is from single family or duplex residential structures on individual lots. Detention facilities for the above mentioned land uses shall be located in a tract or right-of-way dedicated to the City.

   c. The City does not accept maintenance responsibility for private storm water conveyance, detention, or water quality systems. Private systems include single family residential (not associated with a subdivision or multiple lot residential development), multifamily development, industrial, or commercial and all redevelopment for the above mentioned land uses.

   d. Maintenance requirements for stormwater facilities are identified in the King County Manual. A maintenance plan shall be submitted to the City for approval along with the design and analysis calculations prepared for the construction permit application.

   e. For public facilities, the City will assume maintenance responsibility two years after final construction approval by the City and upon passing an inspection by City inspectors to ensure the facility has been properly maintained, the vegetation clearly established, and the facility is operating as designed. The site developer/owner shall provide a maintenance bond to the City that shall remain in effect until the facilities are accepted by the City.

   f. The City reserves the right to perform maintenance on private facilities if those facilities are found to have the potential to have a negative impact on public facilities or water quality. The City will charge the owner for all expenses incurred from City performed maintenance.

L. Water Quality Facilities

1. When Required

All new development and redevelopment are required to construct quality facilities to reduce the contaminants entering the storm collection and surface water systems. The stormwater facilities shall be designed to remove 70 percent of the total suspended solids (TSS) entering the facility during the water quality design storm. This policy may require the use of a combination of water quality facilities to achieve the designed removal rate.

2. Standards

   a. Water quality facilities shall be designed in accordance with criteria as established in the *King County, Washington Surface Water Design Manual*, September 1998 or the most recent final version.

   b. Acceptable water quality facilities include vegetated swales, water quality ponds, sedimentation ponds, water quality inlets, and infiltration facilities.

   c. The use of infiltration facilities is recommended where soil and slope conditions permit the use of this type of facility and the facilities do no have an adverse impact to adjacent or downhill properties.

   d. The use of multiple water quality facilities may be required to meet the performance standard. Chapter 6 of the King County Manual identifies seven types of treatment facilities that will meet the performance standards.

   e. Water quality facilities must be designed to safely pass without damage to the facility flows in excess of the water quality design storm up to the 100-year, 24-hour event. For some facilities, a bypass system will be required.

3. Access and Maintenance Responsibility

   a. Water quality facility access tracts, easements or permanent right-of-ways are required when the facilities do not abut the public right-of-way. All-weather road(s) shall provide access to the facility and the control structure as required for vehicular maintenance access.

   b. The City will assume maintenance and operation responsibility for water quality facilities within the improved public right-of-way for any residential subdivision with two or more lots, and any similar development or redevelopment where at least two-thirds of the developed contributing area is from single family or duplex residential structures on individual lots. Water quality facilities for the above mentioned land uses shall be located in a tract or right-of-way dedicated to the City.

   c. The City does not accept maintenance responsibility for private storm water quality systems. Private systems include single family residential (not associated with a subdivision or multiple lot residential development), multifamily development, industrial, or commercial and all redevelopment for the above mentioned land uses.

   d. Maintenance requirements for the facilities are identified in the King County Manual. A maintenance plan shall be submitted to the City for approval along with the design and analysis calculations prepared for the construction permit application. The maintenance plan shall describe the maintenance activity and frequency of execution.

e. For public facilities, the City will assume maintenance responsibility two years after final construction approval by the City and upon passing a City inspection to ensure the facility has been properly maintained and is operating as designed. The site developer/owner shall provide a maintenance bond to the City that shall remain in effect until the facilities are accepted by the City.

f. The City reserves the right to perform maintenance on private facilities if those facilities are found to have the potential to have a negative impact on public facilities or water quality. The City will charge the owner for all expenses incurred from City performed maintenance.

APPENDIX G
FEDERAL REGISTER FOR ESA 4(D) RULE

Federal Register

Monday,
July 10, 2000

Part II

Department of Commerce

National Oceanic and Atmospheric Administration

50 CFR Part 223

Endangered and Threatened Species; Salmon and Steelhead; Final Rules

DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

50 CFR Part 223

[Docket No. 991207324–0148–02; I.D. 081699C]

RIN 0648–AK94

Endangered and Threatened Species; Final Rule Governing Take of 14 Threatened Salmon and Steelhead Evolutionarily Significant Units (ESUs)

AGENCY: National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration (NOAA), Commerce.

ACTION: Final rule.

SUMMARY: Under section 4(d) of the Endangered Species Act (ESA), the Secretary of Commerce (Secretary) is required to adopt such regulations as he deems necessary and advisable for the conservation of species listed as threatened. NMFS now issues a final ESA 4(d) rule adopting regulations necessary and advisable to conserve fourteen listed threatened salmonid ESUs. This final rule applies the prohibitions enumerated in section 9(a)(1) of the ESA to one coho salmon ESU, three chinook salmon ESUs, two chum salmon ESUs, one sockeye salmon ESU and seven steelhead ESUs. NMFS does not find it necessary and advisable to apply the take prohibitions described in section 9(a)(1)(B) and 9(a)(1)(C) to specified categories of activities that contribute to conserving listed salmonids or are governed by a program that adequately limits impacts on listed salmonids. This final rule includes 13 such limits on the application of the ESA section 9(a)(1) take prohibitions.

DATES: Effective September 8, 2000. Applicability dates: In § 223.203 for the Snake River Basin, Lower Columbia River, Middle Columbia River, Upper Willamette River, Central Valley, California, Central California Coast, and South-Central California Coast steelhead ESUs, this final rule is applicable September 8, 2000. In § 223.203 for the Snake River spring/summer, Snake River fall, Puget Sound, Lower Columbia River and Upper Willamette River chinook, Oregon Coast, Central California Coast, and South/Central California Coast coho, Hood Canal summer-run and Columbia River chum, and Ozette Lake sockeye ESUs, this final rule is applicable January 8, 2001.

ADDRESSES: Branch Chief, NMFS, Northwest Region, Protected Resources Division, 525 NE. Oregon St., Suite 500, Portland, OR 97232–2737; Regional Administrator, Northwest Region, 7600 Sand Point Way, NE, BIN C15700, Building 1, Seattle, WA 98115–0070; Assistant Regional Administrator, Protected Resources Division, NMFS, Southwest Region, 501 West Ocean Blvd., Suite 4200, Long Beach, CA 90802-4213; Regional Administrator, NMFS, Southwest Region, 501 West Ocean Blvd., Long Beach, CA 90802–4213; Salmon Coordinator, Office of Protected Resources, NMFS, 1315 East-West Highway, Silver Spring, MD 20910.

FOR FURTHER INFORMATION CONTACT: Garth Griffin at 503-231-2005 or Craig Wingert at 562–980–4021.

Electronic Access

Reference materials regarding this rule can also be obtained from the internet at www.nwr.noaa.gov.

SUPPLEMENTARY INFORMATION:

Background

On August 18, 1997, NMFS published a final rule listing the Snake River Basin (SRB), Central California Coast (CCC), and South/Central California Coast (SCCC) steelhead (*Onchorynchus mykiss*) ESUs as threatened species under the ESA (62 FR 43937). On March 19, 1998, NMFS published a final rule listing the Lower Columbia River (LCR) and Central Valley, California (CVC) steelhead ESUs as threatened species under the ESA (63 FR 13347). On March 25, 1999, NMFS published a final rule listing the Middle Columbia River (MCR) and Upper Willamette River (UWR) steelhead ESUs as threatened (64 FR 14517). Those final listing documents describe the background of the steelhead listing actions and provide summaries of NMFS' conclusions regarding the status of the listed steelhead ESUs. On August 10, 1998 (63 FR 42587), NMFS, on behalf of the Secretary, published a final rule listing the Oregon Coast (OC) ESU of coho salmon (*Oncorhynchus kisutch*, or *O. kisutch*) as threatened. By a final rule published on March 24, 1999 (64 FR 14308), NMFS listed as threatened the Puget Sound (PS), Lower Columbia River (LCR) and Upper Willamette River (UWR) ESUs of west coast chinook salmon (*Oncorhynchus tshawytscha*, or *O. tshawytscha*) in Washington and Oregon. By a final rule published on March 25, 1999 (64 FR 14508), NMFS listed as threatened the Hood Canal Summer-run (HCS) and Columbia River (CR) chum salmon ESUs (*Oncorhynchus keta*, or *O. keta*) in Washington and Oregon. By a final rule published on March 25, 1999 (64 FR 14528), NMFS listed as threatened the Ozette Lake ESU of sockeye salmon (*Oncorhynchus nerka*, or *O. nerka*) in Washington. Those final rule listing notifications describe the background of the listing actions and provide a summary of NMFS' conclusions regarding the status of the threatened coho, chinook, chum, and sockeye salmon ESUs.

Section 4(d) of the ESA provides that whenever a species is listed as threatened, the Secretary shall issue such regulations as he deems necessary and advisable to provide for the conservation of the species. Such protective regulations may include any or all of the prohibitions that apply automatically to protect endangered species under ESA section 9(a)(1). Those section 9(a)(1) prohibitions, in part, make it illegal for any person subject to the jurisdiction of the United States to take (including harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect; or to attempt any of these), import or export, ship in interstate commerce in the course of commercial activity, or sell or offer for sale in interstate or foreign commerce any wildlife species listed as endangered, without written authorization. It is also illegal under ESA section 9(a)(1) to possess, sell, deliver, carry, transport, or ship any such wildlife that has been taken illegally. Section 11 of the ESA provides for civil and criminal penalties for violation of section 9 or of regulations issued under the ESA.

Whether section 9(a)(1) prohibitions or other protective regulations are necessary and advisable is in large part dependent upon the biological status of the species and potential impacts of various activities on the species. These threatened species are likely to become endangered species within the foreseeable future. Their current threatened status cannot be explained by natural cycles in ocean and weather conditions. NMFS has concluded that threatened chinook, coho, chum, sockeye, and steelhead are at risk of extinction primarily because their populations have been reduced by human "take". West Coast populations of these salmonids have been depleted by take resulting from harvest, past and ongoing destruction of freshwater and estuarine habitats, hydropower development, hatchery practices, and other causes. "Factors for Decline: A Supplement to the Notice of Determination for West Coast Steelhead" (NMFS, 1996) and "Factors Contributing to the Decline of Chinook Salmon: An Addendum to the 1996 West Coast Steelhead Factors for Decline Report" (NMFS, 1998) concludes that all of the factors identified in section 4(a)(1) of the ESA have played some role in the decline of the species. It is necessary and advisable then to apply the ESA section 9(a)(1) prohibitions to these listed ESUs, in order to provide for their conservation.

These listings have created a great deal of interest among states, counties, and others in adjusting their programs that may affect the listed species to ensure they are consistent with salmonid conservation. Although the primary purpose of state, local, and other programs is generally to further some activity other than conserving salmon, such as maintaining roads, controlling development, ensuring clean water or harvesting trees, some entities have adjusted one or more of these programs to protect and conserve listed salmonids. NMFS believes that with appropriate safeguards, many such activities can be specifically tailored to minimize impacts on listed threatened salmonids to an extent that makes additional Federal protections unnecessary for conservation of the listed ESU.

NMFS, therefore, proposes a mechanism whereby entities can be assured that an activity they are conducting or permitting is consistent with ESA requirements and avoids or minimizes the risk of take of listed threatened salmonids. When such a program provides sufficient conservation for listed salmonids, NMFS does not find it necessary and advisable to apply ESA section 9(a)(1) take prohibitions to activities governed by those programs. In those circumstances (see descriptions to follow), additional Federal ESA regulation through imposing the take prohibitions is not necessary and advisable because it would not enhance the conservation of the listed ESUs. In fact, declining to apply take prohibitions to such programs likely will result in greater conservation gains for a listed ESU than would blanket application of section 9(a)(1) prohibitions, through the program itself and by demonstrating to similarly situated entities that practical and realistic salmonid protection measures exist. NMFS will monitor the activities under a program where NMFS has granted a "limit" on the application of the ESA take prohibitions for unexpected harm, as well as for harmful activities resulting in take that do not obey the requirements of the limit and, therefore, are subject to NMFS ESA enforcement. An additional benefit of this approach is that NMFS can focus its enforcement efforts on activities and programs that have not yet adequately addressed the conservation needs of listed ESUs.

Substantive Content of Final Regulation

NMFS had previously proposed protective regulations for three of the salmonid ESUs subject to this final rule. When NMFS first proposed the Oregon Coast coho for listing (60 FR 38026, July 25, 1995), it proposed to apply the prohibitions of ESA section 9(a)(1) to that ESU. When NMFS first proposed the LCR and SRB steelhead ESUs for listing (61 FR 41541, August 9, 1996), it also proposed to apply the prohibitions of ESA section 9(a)(1) to those ESUs. These proposed protective regulations, however, were never finalized. NMFS has since proposed application of the section 9(a)(1) prohibitions for seven listed steelhead ESUs (64 FR 73479, December 30, 1999), and seven listed salmonid ESUs (65 FR 170, January 3, 2000). This final rule applies the prohibitions of ESA section 9(a)(1) to all 14 listed ESUs.

NMFS concludes that the prohibitions generally applicable for endangered species are necessary and advisable for conservation of these listed ESUs. Additionally, NMFS determines that section 9(a)(1) prohibitions on listed salmonids in the 14 listed ESUs need not be applied when it results from a specified subset of activities described herein. These are activities that are conducted in a way that contributes to conserving the listed ESUs and where NMFS determines that added protection through Federal regulation is not necessary and advisable for conservation of an ESU. Therefore, NMFS will now apply ESA section 9(a)(1) prohibitions to these 14 threatened salmonid ESUs, but will not apply the take prohibitions to the 13 programs described in this document as meeting that level of protection. Of course, the entity responsible for any habitat-related programs might equally choose to seek an ESA section 10(a)(1)(b) permit, or be required to satisfy ESA section 7 consultation if Federal funding, management or approval is involved. This final rule does not impose restrictions beyond those applied in other sections of the ESA, but provides another option beyond the section 7 and 10 tools to authorize incidental take.

Working with state and local jurisdictions and other resource managers, NMFS has identified 13 programs and criteria for future programs for which it is not necessary and advisable to impose ESA section 9(a)(1) prohibitions because they contribute to conserving the ESU. Under specified conditions and in appropriate geographic areas, these programs and criteria include: (1) activities conducted in accord with ESA incidental take authorization; (2) ongoing scientific research activities, for a period of 6 months from the publication of this final rule; (3) emergency actions related to injured, stranded, or dead salmonids; (4) fishery management activities; (5) hatchery and genetic management programs; (6) activities in compliance with joint tribal/state plans developed within *United States* (U.S.) v. *Washington* or *U.S.* v. *Oregon*; (7) scientific research activities permitted or conducted by the states; (8) state, local, and private habitat restoration activities; (9) properly screened water diversion devices; (10) routine road maintenance activities; (11) certain park pest management activities; (12) certain municipal, residential, commercial, and industrial (MRCI) development and redevelopment activities; and (13) forest management activities on state and private lands within the State of Washington. The language which follows describes each limit. These are programs or criteria for future programs where NMFS will limit the application of the section 9(a)(1) prohibitions. More comprehensive descriptions of each limit and discussions regarding the scientific basis for this final rule are contained in "A Citizen's Guide to the 4(d) Rule" (NMFS, 2000). In the future, NMFS anticipates adding new limits for more activities that are deemed necessary and sufficient for the conservation of the species.

NMFS emphasizes that these limits are not prescriptive regulations. The fact of not being within a limit does not mean that a particular action necessarily violates the ESA or this regulation. Many activities do not affect these species, and thus, need not be included in the 13 limits listed earlier. The limits describe circumstances in which an entity or actor can be certain it is not at risk of violating the take prohibitions or of consequent enforcement actions, because the take prohibitions would not apply to programs or activities within those limits. Jurisdictions, entities, and individuals are encouraged to evaluate their practices and activities to determine the likelihood of take occurring. NMFS can provide ESA coverage through section 4(d) rules, section 10 research and enhancement permits, or incidental take permits; or through section 7 consultations with Federal agencies. If take is likely to occur, then the jurisdiction, entity or individual should modify its practices to avoid take of a threatened species or seek protection from potential ESA liability through section 7, section 10, or section 4(d) processes.

Jurisdictions, entities, and individuals are not required to seek inclusion in a section 4(d) limit from NMFS. In order to reduce its liability, a jurisdiction, entity, or individual may also informally comply with a limit by choosing to modify its programs to be consistent with the evaluation considerations described in an individual limit. Finally, a jurisdiction, entity, or individual may seek to qualify its plans or ordinances for inclusion in a limit by obtaining the 4(d) limit authorization from the appropriate NMFS Regional Administrator (see **ADDRESSES**).

NMFS wishes to continue to work collaboratively with all affected jurisdictions, entities, and individuals to recognize management programs that conserve and meet the biological requirements of salmonids, and to strengthen other programs toward conservation of listed salmonids. This final rule may be amended to add new limits on the take prohibitions, or to amend or delete limits as circumstances warrant.

State, county and local efforts such as Clark, Cowlitz, Kitsap, the Puget Sound Tri-County Initiative in Washington state; and the City of Portland and Clackamas County in Oregon are working with NMFS to make their ordinances and practices fish friendly and to be adopted in future 4(d) rulemaking. NMFS also acknowledges the important progress being made by Metro, the directly-elected regional government in Portland, Oregon. NMFS is enthusiastic about Metro's current planning efforts and encourages its progress in regional planning to address salmonid conservation.

NMFS acknowledges, and is participating in, the State of Washington's Agricultural, Fish, and Water negotiation process currently underway in Washington State. The process currently underway is intended to address the requirements of the ESA and the Clean Water Act (CWA). The negotiations are designed to address agricultural practices and processes including but not limited to: Field Office Technical Guides (FOTGs), Comprehensive Irrigation District Management Plans (CIDMP), Ditch Maintenance Plans (DMPs) and Pesticide Management as needed to comply with ESA and CWA. It is anticipated that completed FOTGs, CIDMPs, DMPs, and Pesticide Management, if acceptable to NMFS, will be included in future ESA 4(d) rulemaking.

NMFS strongly encourages comprehensive conservation planning for programs at the state level. State level conservation programs can be one of the most efficient methods to implement effective conservation practices across the board and achieve comprehensive benefits for listed fish and their habitats. Other examples of these state-based conservation programs include the completed forestry agreement in Washington state; ongoing reviews of Oregon and California forestry practices; and development of coastal states' shoreline management programs. NMFS is working with Washington State Department of Ecology on development of a model shoreline program. Alternatively, a local jurisdiction seeks inclusion in a limitation of the take prohibition by adopting this model program, NMFS expects to address the potential "take" issues associated with the shorelines program through an ESA section 7 consultation with the National Ocean Service in the coming months. This may obviate the need for a 4(d) limit for shoreline-related activities under the authority of the Department of Ecology.

Concurrent with this final rule, NMFS is publishing a final rule describing a limit on the section 9(a)(1) prohibitions for actions in accord with any tribal resource management plan that the Secretary has determined will not appreciably reduce the likelihood of survival and recovery of a threatened ESU (published elsewhere in this **Federal Register** issue).

Following is a section entitled "Notice of Availability" which lists seven documents referred to in the regulation. The purpose of making these documents available to the public is to inform governmental entities and other interested parties of the technical components NMFS expects to be addressed in programs submitted for its review. These technical documents provide guidance to entities as they consider whether to submit a program for a 4(d) limit. The documents represent several kinds of guidance, and are not binding regulations requiring particular actions by any entity or interested party.

For example, NMFS' Viable Salmonid Policy (VSP) paper referenced in the fishery and harvest management limits provides a framework for identifying populations and their status as a component of developing adequate harvest or hatchery management plans. This rule asks that FMEPs and HGMPs "utilize the concepts of 'viable' and 'critical' salmonid population thresholds, consistent with the concepts contained in the [VSP paper]." Thus, state fishery agencies preparing such programs are put on notice of the technical analysis needed to support decisions within a program. Similarly, NMFS' Fish Screening Criteria explicitly recognize that they are general in nature and that site constraints or particular circumstances may require adjustments in design, which must be developed with the NMFS staff member, or authorized officer, to address site specific considerations and conditions. Finally, research involving electrofishing comes within the scientific research limit only if conducted in accordance with NMFS' Guidelines for Electrofishing. The guidelines recognize that other techniques may be appropriate in particular circumstances, and NMFS can recognize those as appropriate during the approval process.

Of the state or local documents referenced in the rules, two (Oregon Department of Transportation's (ODOT) road maintenance program to govern routine maintenance activities and Portland Parks' integrated pest management program) are existing programs already being implemented that NMFS has found adequate and made effective as limits. Those entities, thus, need no further approval for the programs. Other jurisdictions may come within the road maintenance limit if they use the ODOT program or provide other practices found by NMFS to be equivalent or more protective of salmonids. The State of Washington's Forests and Fish Report will not trigger a limit until the Washington Board of Forestry adopts regulations that NMFS finds are at least as protective as the report. Thus, the report indicates a set of conditions that will allow NMFS to approve the limit, but recognizes that the Board may design regulations that are not identical to, but are at least as protective as, the report language.

In sum, where the rule cites a document, a program's consistency with the guidance is "sufficient" to demonstrate that the program meets the particular purpose for which the guidance is cited. However, the entity or individual wishing a program to be accepted as within a particular limit has the latitude to show that its variant or approach is, in the circumstances where it will apply and affect listed fish, equivalent or better.

NMFS will continue to review the applicability and technical content of its own documents as they are used in the future and make revisions, corrections or additions as needed. NMFS will use the mechanisms of the rule to take comment on revisions of any of the referenced state programs. If any of these documents is revised and NMFS relies on the revised version to provide guidance in continued implementation of the rule, NMFS will publish in the **Federal Register** a notice of its availability stating that the revised document is now the one referred to in the specified 223.203(b) subsection.

Notice of Availability

The following is a list of documents cited in the regulatory text of this final rule. Copies of these documents may be obtained upon request (see ADDRESSES).

1. Oregon Department of Transportation (ODOT) Maintenance Management System Water Quality and Habitat Guide (June, 1999).
2. City of Portland, Oregon Parks and Recreation Department Pest Management Program (March 1997) with Waterways Pest Management Policy updated December 1, 1999.
3. State of Washington, Forests and Fish Report (April 29, 1999).
4. Guidelines for Electrofishing Waters Containing Salmonids Listed Under the Endangered Species Act (NMFS, 2000a).
5. Juvenile Fish Screen Criteria, National Marine Fisheries Service, Northwest Region, Revised February 16, 1995, with Addendum of May 9, 1996.
6. Fish Screening Criteria for Anadromous Salmonids (January 1997).
7. Viable Salmonid Populations and the Recovery of Evolutionarily Significant Units. (NMFS, 2000b).

Copies of all references, reports, related documents and "A Citizen's Guide to the 4(d) Rule" (NMFS, 2000) are also available upon request (see ADDRESSES).

The limits on the take prohibitions do not relieve Federal agencies of their duty under section 7 of the ESA to consult with NMFS if actions they fund, authorize, or carry out may affect listed species. To the extent that actions subject to section 7 consultation are consistent with a circumstance for which NMFS has limited the take prohibitions, a letter of concurrence from NMFS will greatly simplify the consultation process, provided the program is still consistent with the terms of the limit.

Applicability to Specific ESUs

In the regulatory language in this final rule, the limits on applicability of the take prohibitions to a given ESU are accomplished through citation to the Code of Federal Regulations' (CFRs') enumeration of threatened marine and anadromous species, 50 CFR 223.102. For the convenience of readers of this notice, 50 CFR 223.102 refers to threatened salmonid ESUs through the following designations:

(a) (1) Snake River spring/summer chinook
(a) (2) Snake River fall chinook
(a) (3) Central California Coast coho
(a) (4) Southern Oregon/Northern California Coast coho
(a) (5) Central California Coast steelhead
(a) (6) South-Central California Coast steelhead
(a) (7) Snake River Basin steelhead
(a) (8) Lower Columbia River steelhead
(a) (9) Central Valley, California steelhead
(a) (10) Oregon Coast coho
(a) (12) Hood Canal summer-run chum
(a) (13) Columbia River chum
(a) (14) Upper Willamette River steelhead
(a) (15) Middle Columbia River steelhead
(a) (16) Puget Sound chinook
(a) (17) Lower Columbia River chinook
(a) (18) Upper Willamette River chinook
(a) (19) Ozette Lake sockeye

Summary of Comments in Response to the Proposed Rules

Between January 10, 2000, and February 22, 2000, NMFS held 25 public hearings to solicit comments on the proposed ESA 4(d) rules: 7 in Washington, 8 in Oregon, 3 in Idaho, and 7 in California (64 FR 73479, December 30, 1999; 65 FR 170, January 3, 2000; 65 FR 7346, February 14, 2000; 65 FR 7819, February 16, 2000). During the 65-day public comment period, NMFS received 1,146 written comments on the proposed rules from Federal, state, and local government agencies; Indian tribes; non-governmental organizations; the scientific community; and individuals. In addition, numerous individuals provided oral testimony at the public hearings.

Based on these public hearings and comments, NMFS now issues its final protective regulations for these 14 salmon and steelhead ESUs. The preamble section of this rule refers to the prohibitions of ESA section 9(a)(1). In addition to the commonly referred to take prohibitions of section 9(a)(1)(B) and 9(a)(1)(C), section 9(a)(1), also includes prohibitions on the import, export, sale, delivery, or transport in interstate commerce of endangered species. The public comments NMFS received almost exclusively focused on the section 9 take prohibitions. The following comments and responses, therefore, refer to the "take" prohibitions of section 9(a)(1)(B) and 9(a)(1)(C), not to the other prohibitions described in section 9(a)(1). Accordingly, for the rest of this preamble and in the regulation, the term "prohibition" refers to the prohibition of take within the 13 specified limits.

New information and a summary of comments received in response to the proposed rules are summarized as follows.

Comments and Responses

Take Guidance

Comment 1: Some commenters stated that a primary focus of the proposal was to encourage development of local tailor-made measures that protect salmonids and they requested further guidance on how their programs could be included in future ESA 4(d) rules.

Response: Credible local initiatives are indeed needed to help save these species, and guidance on how local programs can be included in 4(d) rules is available in *The ESA and Local Governments: Information on 4(d) Rules, May 7, 1999*. In addition, NMFS staff will be available to offer advice and otherwise help individual jurisdictions and entities ensure that their actions do not take listed fish.

Comment 2: Some commenters wanted a simplified process (e.g., a "letter of approval" from NMFS staff) for including local programs in future ESA 4(d) rules.

Response: NMFS worked with state and local authorities to identify several categories of activities where local programs can be certified to comply with ESA requirements if they meet the conditions described in the rule. This simplified process would be available for land-use development activities, water diversion screening, road maintenance, hatchery operations, fisheries harvest, fisheries related research, and habitat restoration activities. Other governmental entities are encouraged to step forward and work with NMFS. First, to ensure that local programs meet the salmon's biological requirements and the mandates of the ESA, and second, to streamline the administration of any program.

Comment 3: A number of commenters stated that the proposed take guidance was too vague (e.g., guidance in the limit for new urban density development). Others commented that the guidance was too prescriptive, and still others stated that the guidance was less stringent for some categories of activities and more stringent for others.

Response: To be approved for a limit from ESA take prohibitions, a program must conserve salmon and meet their biological requirements. This criterion is the same for all programs. These species span the entire west coast from coastal rainforests to arid inland areas to high mountain regions nearly a thousand miles from the ocean and, thus, specific requirements will naturally differ from place to place. Some jurisdictions have asked for NMFS' help in learning how to avoid or limit adverse impacts on these species. General guidance is provided in this rule. This final 4(d) rule addresses concerns about vague guidance by providing additional specificity and by requiring that once specific programs designed to meet NMFS' criteria are produced (and before determining whether they are adequate), NMFS will publish the proposed program for review and comment.

Comment 4: Some commenters stated that NMFS must wait to apply take prohibitions until more specific guidance is published on how other programs can qualify for a limit on the take prohibitions. Others requested that NMFS delay take prohibitions until many more local programs were ready to be included in an ESA 4(d) rule, or that NMFS phase in the take prohibitions as programs qualify for a limit.

Response: These species are, by definition, likely to become endangered in the foreseeable future and undue delay in protecting them would likely increase the difficulty and expense of recovering them. At the same time, NMFS recognizes these rules are novel and complicated and some time is needed for regulated parties to better understand them. NMFS has balanced these considerations by adopting a final rule that puts needed regulations in place within 60 days for the steelhead ESUs and within 180 days for the salmon ESUs, which allows a reasonable period before they become effective (6 months).

Comment 5: A few commenters wanted NMFS to grant a grace period from the take prohibitions to those jurisdictions making good faith efforts to conserve the species.

Response: The proposed rule already states that while enforcement may be initiated against activities that take protected salmonids, NMFS' clear preference is to work with persons or entities to promptly shape their programs and activities to include credible and reliable conservation measures.

Comment 6: Some commenters asked NMFS to apply prohibitions against take to all programs without exception.

Response: Any jurisdiction or individual under United States authority is subject to the take prohibitions. Jurisdictions or individuals wanting assurance that an activity they are conducting or permitting is consistent with ESA requirements can be covered under a section 7 consultation (if Federal funding, authorization, or management is involved), seek an ESA section 10 permit, or qualify for a limit under a 4(d) rule. To qualify for any of these options, the activity must show that it sufficiently conserves the listed species.

Comment 7: Some commenters wanted NMFS to define the action types and magnitudes that would constitute illegal take. Others held that the array of activities described in the proposed rule that are "likely to injure or kill listed salmonids" was overly inclusive and discussed actions that exceeded NMFS' authority to regulate. Still others requested that NMFS assert that state and local governments are not required to use their regulatory authorities to satisfy ESA requirements.

Response: It is NMFS' policy to increase public awareness of and identify those activities that would or would not likely injure or kill a protected species. Take guidance appearing at the end of this document does just that. It is only possible in this final rule to describe categories of actions that may have adverse impacts on fish and describe their consequences (e.g., blocking fish from reaching their spawning grounds, dewatering incubating eggs, etc.). NMFS understands that there is considerable interest in knowing as much as possible about what constitutes "take" and changes have been incorporated in this final rule to accommodate this interest. Determining whether an individual local program or activity is likely to injure or kill a protected species will require credible assessments that take into account local factors and conditions. Regarding the issue of authority, regulations against killing or injuring protected species apply to any person subject to the jurisdiction of the United States (section 9(a)(1) of the ESA). The term "person" means an individual, corporation, partnership, trust, association, or any other private entity; or any officer, employee, agent, department, or instrumentality of the Federal Government, of any State, municipality, or political subdivision of a State, or of any foreign government; and State, municipality, or political subdivision of a State; or any other entity subject to the jurisdiction of the United States (ESA section 3(12)).

Comment 8: A few commenters requested that NMFS make clear that "take" prohibitions would not be violated unless a protected species were injured or killed, and that determinations of whether "take" is likely to occur will be handled on a case-by-case basis.

Response: The term "take" means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, a listed species or to attempt to engage in any such conduct (ESA section 3(18)). The term "harm" refers to an act that actually kills or injures a protected species (64 FR 215 (November 8, 1999). Harm can arise from significant habitat modification or degradation where it actually kills or injures protected species by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering. After conducting a self- assessment to determine whether an activity is likely to "take" a listed species, persons or entities may choose to adjust their program to avoid take, or pursue ESA coverage through a section 10 permit, a section 7 consultation with Federal agencies, or through a 4(d) rule.

Comment 9: Commenters requested that adequate monitoring and oversight be required to ensure that programs included in an ESA 4(d) rule are effective.

Response: A program is incomplete without a mechanism to track its implementation and effectiveness. NMFS reiterates language in the proposed rule which states that for any program included in an ESA 4(d) rule, "NMFS will evaluate on a regular basis the effectiveness of the program in protecting and achieving a level of salmonid productivity and/or habitat function consistent with the conservation of the listed salmonids." If a program does not meet its objectives, NMFS will work with the relevant jurisdiction to adjust the program accordingly. If the responsible entity chooses not to adjust the program accordingly, NMFS will publish notification in the **Federal Register** and announce that the program will no longer be free from ESA take prohibitions because it does not sufficiently conserve listed salmonids.

Comment 10: There were a number of requests for NMFS to grant limits on the take prohibitions to additional programs. Examples included, the Natural Resources Conservation Service's FOTGs, California's Lake and Streambed Alteration Program, Oregon Concrete and Aggregate Producer's suggestions for a limit focused on Department of Geology regulation, Washington's Tri-County initiative, and

The Oregon Plan for Salmon and Watersheds.

Response: The ESA 4(d) rule provides an option for state and other jurisdictions to assume leadership for species conservation at the state and local level over and above the conventional tools for processing state and local conservation planning under the ESA through section 7 consultations and section 10 permitting. NMFS is assembling all the Federal, tribal, state, and local programs needed to save salmonids and has offered to collaborate with any entity interested in this 4(d) option. NMFS is especially interested in state-level conservation efforts because state-level programs tailored to meet the needs of the listed stocks can be a very efficient and comprehensive method to provide for the conservation of listed stocks and their habitat. A number of state and local entities have stepped forward to work with NMFS and we are anxious to work with them. However, limits that were not outlined in the proposed rule for public comment will have to be dealt with in a future amendment.

Comment 11: Commenters requested that NMFS clarify that activities conducted pursuant to an approved state or Federal permit are free from the ESA section 9 take prohibitions.

Response: Activities conducted pursuant to an approved state or Federal permit are subject to take prohibitions. Individual programs can seek relief from any take liability through a section 7 consultation, a section 10 permit process, or a program approved under a 4(d) limit.

Comment 12: Commenters argued that the nature of some programs (e.g., road construction, gravel mining, water withdrawals, levee construction, and certain development) should disqualify them from consideration for limits on take prohibitions under an ESA 4(d) rule.

Response: Under the proposal, all programs must fulfill the same standard to be included in an ESA 4(d) rule (i.e., they must conserve the species and meet their biological requirements). The important issue here is that threatened salmonids need meaningful, practical, and reliable conservation measures. Some programs will naturally have more difficulty meeting that standard than others. The ESA 4(d) rule simply applies the take prohibitions and allows for the development and implementation of conservation measures.

Comment 13: Several commenters suggested that the use of pesticides and herbicides should be considered a resource management tool and, therefore, be included as a limit by NMFS in the 4(d) rule. Several commenters argued that the proposed take guidance violates the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) and, thereby, trespasses unlawfully into Environmental Protection Agency (EPA) authorities and violates the take exemption provided for FIFRA-registered pesticides.

Response: NMFS acknowledges that some view the current use of pesticides as essential to successful commercial crop production on agricultural lands, certain types of habitat restoration projects, and dealing with invasive exotic species. NMFS does not currently have specific information on the potential effects on listed salmonids of the very large number of pesticide products currently in use. Accordingly, NMFS is not able to conclude that the otherwise lawful use of these products is sufficiently benign to warrant an explicit limitation of the take prohibition in this rule. NMFS, therefore, has not incorporated such a limit.

For the same reason, NMFS is also unable to make an affirmative finding that the otherwise-lawful use of these products may cause harm to listed salmonids in potential violation of this final rule.

NMFS will continue to conduct scientific research into the potential for adverse effects upon salmonids of a variety of pesticides. NMFS intends to work closely with EPA and state authorities which have primary responsibility for ensuring the proper use of these products under relevant Federal and state regulatory regimes. Should information come forward to suggest that the otherwise lawful use of a pesticide harms or injures listed salmonids and might be in violation of this rule, NMFS anticipates addressing the concern through a section 7 consultation with EPA, NRCS, or United States Fish and Wildlife Service (FWS) as appropriate, or corresponding discussions with responsible state authorities. NMFS prefers this approach rather than use its enforcement authorities against an individual applicator for the otherwise-lawful use of the pesticide. Similarly, if NMFS, with due consideration of any more restrictive state requirements for a pesticide's use, finds that a limitation on the prohibition against take for the use of selected pesticides is necessary and advisable for the conservation of listed salmonids, it may amend this rule accordingly. Through such a programmatic approach, NMFS believes that it will be able to achieve an orderly and comprehensive analysis of the use of pesticides and their effects on listed salmonids.

Comment 14: A few commenters argued that ESA Habitat Conservation Plans (HCPs) should not be free from take prohibitions under a 4(d) rule.

Response: A section 10 incidental take permit (issued after analyzing the accompanying habitat conservation plan) authorizes a specified level of take. Including incidental take permits in the first limit of this rule is, thus, consistent with the structure and intent of the ESA.

Comment 15: A few commenters requested that NMFS prescribe standards (temporary or otherwise) for agricultural activities to be included in an ESA 4(d) rule.

Response: Different entities (including agricultural interests) have expressed a strong preference for standards developed at the local level (not one-size-fits-all standards). The 4(d) rule was written to foster local interest and support tailor-made programs and NMFS stands ready to work with any interested entity in forging such standards. On the issue of agricultural practices in particular, NMFS is working with a number of agricultural entities to explore conservation practices which might contribute to the conservation of salmonids and their habitats, and is hopeful that these discussions will yield further details on proper conservation practices to help conserve salmon.

Comment 16: A few commenters asked NMFS to work closely with FWS to clarify each other's roles to establish universal standards that cover all listed species.

Response: The two services do work closely together on ESA implementation. For example, NMFS and FWS share identical definitions of "harm" and the proposed rule does state that "as it evaluates any program against the criteria in this rule to determine whether the program warrants a limitation on take prohibitions, NMFS will coordinate closely with FWS regional staffs." This comment, however, is well taken and NMFS will continue to work closely with FWS to coordinate and streamline ESA implementation. NMFS notes that it is commonly requested to distinguish biological requirements of salmonids from biological requirements of other species (some under the jurisdiction of FWS).

Comment 17: Commenters asked NMFS to establish a funding mechanism (e.g., an escrow account) to support habitat restoration activities.

Response: Millions of dollars in Federal funding have been granted to state programs that fund specific habitat restoration projects. NMFS will continue to support funding for these programs in the future.

Comment 18: Several commenters argued that current conditions are a result of past practices, not current practices. They believed that NMFS has failed to justify why the little remaining habitat is important to listed fish and failed to provide detailed scientific rationale to support the agency's contention that certain activities (e.g., urban development) result in take.

Response: NMFS disagrees. The list of examples in this final rule (see Take Guidance) as well as those provided in the proposed rule give general guidance on the types of current activities that are very likely to take threatened salmonids. While not exhaustive, this list was based on direct experience with managing salmonid populations in their natural environment and a thorough understanding of the scientific literature. The ESA listing process for these threatened salmonids has documented the decline of salmonid populations in the four western states and has identified the historic and current causes of these declines. The commenters correctly note that past practices have caused the decline of salmonid populations; however, current human activity can also kill or injure listed salmonids. Development and other human activities within riparian areas or elsewhere in the watershed alter the properly functioning condition of riparian areas. These activities can alter shading (and hence stream temperature), sediment transport and supply, organic litter and large wood inputs, bank stability, seasonal streamflow regimes, and flood dynamics. The natural functions of riparian areas and the ways in which human activities affect those processes and functions are described in the publication entitled "An Ecosystem Approach to Salmonid Conservation" (NMFS, 1996).

Comment 19: Some commenters requested maps of "sensitive resource sites" at a large scale so local jurisdictions that deal with small land parcels may use them. Some commenters stated that NMFS should focus on areas where redds or fish are actually present, not on general definitions such as "spawning gravels."

Response: NMFS acknowledges the value of producing maps that identify resource sites important for the different salmonid life cycle stages. NMFS will continue to work with state entities, local jurisdictions, co-managers and citizens to increase our knowledge of threatened salmonids. NMFS will also continue to increase its own capabilities for mapping resource areas and watersheds. Because there were so many comments requesting that NMFS identify which activities have a high likelihood of resulting in take and will be priorities for enforcement action, the take guidance has been revised to focus on high risk activities. The language referring to "spawning gravels" has, therefore, been removed.

Comment 20: One commenter requested that NMFS add the word "intentional" to clarify the take guidance regarding promotion of predator populations associated with habitat alterations.

Response: NMFS must respectfully disagree. Whether the action is intentional or unintentional, NMFS considers habitat alterations that promote predation on listed species to be undesirable. Such actions may in fact cause injury or harm to listed salmonids.

Comment 21: Several commenters recommended adding sediment discharge to the list of toxic chemicals and other pollutants that are very likely to injure or kill salmonids. Other commenters requested that NMFS clarify which chemicals and pollutants it is referring to in this section.

Response: NMFS refers to toxic chemicals or other pollutants being discharged or dumped and then gives examples by listing sewage, oil, gasoline, and others. Sedimentation from timber harvest and other land use activities may plug the interstitial spaces in gravel spawning areas reducing salmon egg survival during their incubation period as well as many other deleterious effects. Based on these comments and the fact that sediment discharge may harm listed salmonids by physically disturbing or blocking streambed gravels, NMFS added soil disturbances to the list of actions that are likely to kill or injure salmonids.

Comment 22: One commenter urged NMFS to add language in the activity category dealing with the chemical and pollutant discharge or dumping to recognize that take can also occur when these activities are carried out with a valid permit. Another commenter recommended that NMFS clarify which permits are considered "valid," and one commenter stated that this potential "take" should only apply to waters supporting the listed salmonids.

Response: NMFS agrees that chemical and pollutant discharge may take listed fish whether or not there is a valid permit for the discharge. In order to clarify this point, NMFS has deleted the words "particularly when done outside of a valid permit for the discharge" from the take guidance. Regarding the suggestion that take prohibitions should only be applied to waters supporting listed salmonids, the take guidance applies throughout the ESU for the listed species whether or not there are salmonids present in individual rivers or streams.

Comment 23: One commenter noted that the introduction of non-native species likely to prey upon or displace listed species should be expanded to include non-native species that may adversely affect salmonid habitat.

Response: NMFS agrees that non-native species may alter salmonid habitat to such an extent that the habitat may no longer provide all the functions and characteristics that support listed salmonids. The take guidance language now reflects this suggestion.

Comment 24: Numerous commenters argued for language changes and refinements in the descriptions of actions that may injure or kill listed salmonids. The first suggestion is to expand the list of ways fish passage can be blocked to include human-induced physical, chemical, and thermal blockages.

Response: NMFS has revised the take guidance to address this comment and to clarify its enforcement priorities.

Comment 25: Several commenters suggested adding language to the list of activities "very likely to injure or kill salmonids" to address activities that further contribute to or maintain water quality impairments in those water bodies on the 303(d) list of the CWA.

Response: NMFS agrees that this is an important issue and that activities that degrade water quality or maintain degraded conditions can injure listed species. This issue is already addressed in the section on discharging or dumping toxic chemicals or other pollutants into water or riparian areas and in the language changes discussed in the previous comment.

Comment 26: Some commenters urged NMFS to state that water withdrawals can affect salmonids in more ways than adversely modifying spawning and rearing habitat. One commenter also requested that NMFS note that water withdrawals can adversely affect groundwater by capturing flow that might otherwise discharge to surface waters.

Response: NMFS considers "spawning, rearing, and migrating" to be "essential behavioral patterns." The word "migrating" will be added to the take guidance regarding water withdrawals. Regarding the second comment about the potential impact of water withdrawals on groundwater and surface water, NMFS cannot provide further detail in this take guidance because the actual impacts of a given act depend on situation-specific conditions.

Comment 27: Several commenters asked NMFS to expand the discussion of impacts arising from water diversion and flow discharges to include impacts other than changes in stream temperature.

Response: NMFS agrees that water diversions and discharge may have other deleterious effects on salmonid habitat. These may include impacts on sediment transport, turbidity, and stream flow alterations. The actual likelihood that these actions would result in take depends on situation-specific conditions. Based on public comments, the take guidance in the final rule has been revised to clarify NMFS' intent regarding which activities are very likely to injure or kill salmonids and to identify priorities for NMFS enforcement action.

Comment 28: Several commenters recommended moving the topics "water withdrawals" and "violation of federal or state CWA discharge permits" from the section where actions may injure or kill listed fish to the section where actions are "very likely to injure or kill salmonids."

Response: NMFS has revised the take guidance. One change is that water withdrawals have been added to the list of activities that are very likely to injure or kill salmonids. However, the likelihood that take will actually occur depends on the individual action. The issue of actions that violate Federal and state CWA discharge permits is not specifically addressed in the new take guidance language.

Comment 29: One commenter urged NMFS to consider land use activities that affect more than just salmonid habitat. They highlighted the fact that adverse effects include impacts on floodplain function, natural hydrologic patterns, riparian function, and water quality. They also recommended expanding the list of land use activities identified in the proposed rule.

Response: In a section of the preamble of the proposed rule entitled Aids for Understanding the Limits on the Take Prohibition, under Issue 2: Population and Habitat Concepts, NMFS describes properly functioning habitat conditions that create and sustain the physical and biological features essential to conserving the species. These habitat conditions recognize the importance of floodplain function and channel migration and emphasize the dynamic nature of natural systems. NMFS intends the term "salmonid habitat" to be consistent with the habitat functions and processes described in the Habitat Concepts preamble language. NMFS recognizes that different types of land use activities can impact salmonid habitat to such an extent that take may occur. Language has been added to the revised take guidance to address floodplain gravel mining and floodplain development.

Comment 30: Several commenters argued that the take guidance needs to be clarified so that the public can understand what NMFS means in its different categories of take.

Response: NMFS agrees that the take guidance language in the proposed rule caused confusion about which activities can result in take and what actions will be priorities for enforcement. NMFS has revised the take guidance section to focus on those activities that are very likely to injure or kill salmonids.

Comment 31: One commenter suggested amending the proposed language concerning take due to water withdrawals by using Oregon Department of Fish and Wildlife (ODFW) minimum flows to regulate water withdrawals.

Response: NMFS does not reference specific state, local, or private regulations or programs that might prevent take because there is such a large number of programs (and partial programs) in the different states that could be cited. Absent a program approved under section 7 or 10 of the ESA or under this rule, individual jurisdictions and private entities will need to develop, adopt, and implement programs that prevent take.

Comment 32: One commenter suggested that NMFS clarify its intent by using the language "actually impact water quality" in the context of take occurring due to violations of Federal or state CWA discharge permits.

Response: NMFS notes the comment. However, due to changes in the final rule's take guidance language, this specific category of activity has been eliminated.

Comment 33: Some commenters asserted that rural areas were unfairly singled out for engaging in activities that take listed species while urban areas were given ESA 4(d) limits.

Response: NMFS applies the prohibition against take uniformly across the landscape encompassed by the threatened species' ESUs. This take prohibition applies equally to rural areas and urban areas and the take guidance identifies activities that can occur in urban and rural areas. Limits on the take prohibitions were given to complete programs that were shown to conserve salmon and steelhead.

Comment 34: One commenter asked that NMFS clarify the relationship between take avoidance and the designation of critical habitat.

Response: Critical habitat is a geographic description of the areas essential for a species' conservation. These designations highlight important habitat features as well as management actions that may require special management considerations. Take avoidance relates to critical habitat in that special management actions taken (or authorized) by Federal agencies must avoid adversely modifying critical habitat.

Viable Salmonid Populations (VSP)

Comment 35: Several commenters said that NMFS should not base policy on a document that is not complete and has not been reviewed in its final form.

Response: Comments on the December 13, 1999, VSP draft were solicited from over 50 peer reviewers plus tribal and state co-managers. In addition, the document has been available for public comment since the draft ESA 4(d) rules were released. We have received approximately 20 peer and co-manager reviews, plus numerous public comments. These reviews, particularly those from peer-reviewers, have generally been very positive, and the document will require little substantive revision before publication as a NOAA Technical Memorandum in June of 2000.

Comment 36: Several commenters stated that populations are generally smaller than a "distinct population segment" as defined in the ESA and NMFS has "gone too far" in proposing protection of individual populations.

Response: In applying the VSP principles, NMFS does not mean to require equal protection of every single population. The unit requiring protection under the ESA is a "distinct population segment" (i.e., ESU). Therefore, it is the ESU that NMFS must ensure has a minimal risk of extinction. A population is the appropriate biological unit for scientifically evaluating salmonid extinction risk. The status of an ESU can be determined in large part by analyzing the individual populations that constitute the ESU, and determining how their individual statuses combine to affect ESU viability.

Comment 37: Many commenters said that VSP is too vague to be implemented.

Response: Where possible, NMFS has endeavored to provide numerical guidelines for viability thresholds. However, VSP generally does not provide generic quantitative criteria that can be applied to all salmonid populations because the thresholds vary by species and location. This means that applying the VSP principles will require population- and ESU-specific evaluations. This will not be very satisfying to managers looking to VSP for "the answer," but is the only scientifically sound course at this time. NMFS will continue to explore whether generic guidelines (or modeling approaches) may be appropriate for some criteria (e.g., minimum population size), but this requires further analysis and will not be a part of the VSP paper finalized in June. As geographically-specific VSP applications are completed, more general numerical guidelines may be possible.

Comment 38: Several commenters noted that NMFS does not define the relationship of the VSP terms "viable" and "critical" to the ESA terms "threatened" and "endangered."

Response: The VSP paper does not attempt to define "threatened" and "endangered" under the ESA. Defining "threatened" and "endangered" requires policy decisions about the acceptable levels of risk to an ESU that the VSP concept does not address. It is also important to note that the terms viable and critical in VSP are often applied to populations, whereas the unit of interest with regard to the ESA is the ESU.

Comment 39: Several commenters wanted the effects of potential actions to be evaluated on scales other than the population (some desired smaller, some larger).

Response: Although a population is the appropriate unit for studying many biological processes, it may also be appropriate to evaluate management actions that affect units at smaller or larger spatial and temporal scales. For example, ocean harvest plans may affect multiple populations, while a habitat restoration plan only affects a small portion of a single population's habitat. The VSP concept does not preclude establishing goals at these different scales. However, management actions ultimately need to be related to population and ESU viability.

Comment 40: Several commenters said that VSP does not adequately consider the importance of freshwater habitat.

Response: VSP does not attempt to establish the habitat requirements for recovering populations. Habitat criteria are captured, generally, in the concept of Properly Functioning Conditions (PFC) discussed within this rule.

Comment 41: A few commenters said that VSP does not consider important components of recovery planning, such as ecological interactions.

Response: The VSP concept attempts to describe the population level attributes of viable salmonid populations; it does not prescribe how to recover populations. Recovery will require the entire suite of factors that impact salmon throughout their life cycle to be considered and evaluated—including ecological interactions and habitat needs. These are important issues that will need to be dealt with during recovery planning.

Comment 42: Several commenters said that data needed to evaluate VSP parameters will not be available and, therefore, VSP concepts cannot be applied.

Response: Data will generally not be available to thoroughly evaluate every VSP parameter. In developing the VSP guidelines, NMFS tried to consider all the processes that need to be evaluated in order to determine a population's status. If all of these processes cannot be evaluated, the VSP guidelines suggest the type of data that need to be collected. If a VSP guideline cannot be evaluated, managers must explicitly recognize the uncertainty associated with current management decisions because of a data-poor environment. The fact that VSP facilitates this recognition is, in itself, a valuable contribution.

Comment 43: A few commenters said that VSP makes several references to "historic conditions" for evaluating population status, but does not define the time frame for "historic."

Response: Historic conditions are used as a reference point in evaluating population status because under historic conditions populations were assumed to have been viable. The time frame, then, refers to a period in time where the population or ESU was considered self-sustaining and may represent different eras for different groups of fish. However, it should be noted that while historical data can be a valuable tool in evaluating population status, it should not suggest that NMFS will require all populations to be at historic levels in order to be viable. The value placed on historic data and the relationship between recovery goals and historic levels will be ESU- and population-specific.

Comment 44: One commenter argued that given the high levels of uncertainty associated with the ESU viability guidelines, the default assumption should be that all populations need to be viable in order to produce a viable ESU.

Response: This seems to be an appropriately precautionary approach, but responses to uncertainty entail policy decisions that can only be made after carefully analyzing a specific situation.

Comment 45: One commenter said that by defining populations, VSP claims that straying always has negative effects on viability.

Response: In the process of identifying populations, there is no blanket assumption that straying has a negative effect on viability. Straying is a natural process, and appropriate levels of straying within and among viable populations will depend on a balance between the risks and benefits of straying. Indeed, the VSP document acknowledges the potentially critical role that straying plays in extinction and recolonization dynamics among salmonid subpopulations and populations. It should also be noted that human factors (such as stock transfers, blockage of migratory routes, and other habitat alterations) have the potential to increase rates of genetic exchange by one to two orders of magnitude over historic levels. These changes are unlikely to be beneficial.

Comment 46: Several commenters stated that VSP does not consider certain factors to be important when evaluating population status. These factors included (1) marine-derived nutrients, (2) diversity, (3) temporal and spatial structure, and (4) genetic drift.

Response: These topics are covered in the current draft of the VSP document, and some topics may be clarified or expanded during the revision process.

Comment 47: A few commenters said that in evaluating VSP parameters, juvenile fish counts should be considered as well as (or instead of) adult spawner counts.

Response: Although the VSP paper discusses using juvenile fish counts, the guidelines generally focus on adult spawners counts—and not other life stages—because spawner count data sets are prevalent throughout the region and they can be related to the extensive body of conservation biology principles with relative ease. However, NMFS does not go into great detail on monitoring and evaluation programs and should consider any scientifically defensible strategy that allows population status to be evaluated. In some cases, it may be more feasible to collect data on juveniles than adults and it may be possible to assess population viability based primarily on juvenile counts. However, the population evaluation would still need to address the principles outlined in VSP regarding all four parameters (i.e., abundance, productivity, spatial structure, and diversity).

Comment 48: One commenter said NMFS does not take an "ecosystem approach."

Response: It is true that VSP focuses only on Pacific salmonid populations and the ecological processes that directly or indirectly affect them. The paper does not deal explicitly with other species or ecosystem processes that do not affect salmonids. However, given the large geographic scale and the presumed keystone role of salmonids in many ecosystems, an "ecosystem approach" is likely to emerge. Defining the management processes that may support an "ecosystem approach" is outside VSP's scope and intent.

Comment 49: One commenter said that VSP is a framework, not a benchmark, and asserted that the states should have the latitude to develop some of their own benchmarks within this framework.

Response: As noted in a previous response, VSP generally does not provide generic quantitative criteria. Quantitative criteria will be required in setting recovery goals for specific ESUs. In some contexts (often in reference to broad landscapes), the standard is expressed as "seeking to attain or maintain PFC." "Contribute to PFC" is a phrase often used in reference to near-term actions that put habitat on a course to attain PFC over time and is consistent with the standard. Finally, in some circumstances (often in referring to more site-scale decisions), the standard may be expressed as "not precluding PFC." There is no distinction in practice between these expressions of the standard.

Evaluating Habitat Conditions–Properly Functioning Conditions (PFC)

Comment 50: Several commenters opined that PFC should be more clearly defined. Others suggested that specific numeric criteria be included.

Response: Both the preamble and rule texts have been modified to more clearly define PFC and its central role in habitat evaluations. Proper functioning conditions create and sustain over time the physical and biological characteristics that are essential to conservation of the species, whether important for spawning, breeding, rearing, feeding, migration, sheltering, or other functions. Habitat-affecting processes include, but are not limited to vegetation growth, bedload transport through rivers and streams, rainfall runoff patterns, and river channel migration. The concept of proper function recognizes that natural patterns of habitat disturbance, such as through floods, landslides and wildfires, will continue.

NMFS measures conditions on the landscape to evaluate whether and how PFC is likely to be affected, attained or maintained by an activity. The indicators vary between different landscapes based on unique physiographic, geologic or other features. Although the indicators used to assess functioning condition may entail instantaneous measurements, they are chosen, using the best available science, to detect the health of underlying processes, not static characteristics.

The scope of any given activity is important to NMFS' analysis. The scope of the activity may be such that only a portion of the habitat forming processes in a watershed are affected by it. For NMFS to find that an activity is consistent with the conservation of the listed salmonids, only the effects on habitat functions that are within the scope of that activity will be evaluated. For example, an integrated pest management program may affect habitat forming processes related to clean water, but have no effect on physical barriers preventing access by fish to a stream.

NMFS' evaluation of an activity includes an analysis of both direct and indirect effects of the action. "Indirect effects" are those that are caused by the action and are later in time but are still reasonably certain to occur. They include the effects on species or critical habitat of future activities that are induced by the original action and that occur after the action is completed. The analysis also takes into account direct and indirect effects of activities that are interrelated or interdependent with the proposed action. "Interrelated actions" are those that are part of a larger action and depend on the larger action for their justification. "Interdependent actions" are those that have no independent utility apart from the action under consideration. NMFS has published an extensive discussion of the effects of activities in its Consultation Handbook—Procedures for Conducting Consultation and Conference Activities Under section 7 of the Endangered Species Act (March, 1998).

Though there is more than one valid analytical framework for determining effects of an activity, NMFS has developed an analytic methodology it has documented in a Matrix of Pathways and Indicators (MPI; often called "The Matrix"). The MPI can help NMFS and others identify any risks to PFC. The pathways for determining the effects of an action are represented as six conceptual groupings (e.g., water quality, channel condition, and dynamics) of 18 habitat condition indicators (e.g., temperature, width/depth ratio). Default indicator criteria (mostly numeric, though some are narrative) are laid out for three levels of environmental baseline condition: properly functioning, at risk, and not properly functioning. The effect of the action upon each indicator is classified by whether it will restore, maintain, or degrade the indicator.

The MPI provides a consistent, but geographically adaptable, framework for effects determinations. The pathways and indicators, as well as the ranges of their associated criteria, are amenable to alteration through the process of watershed analysis. The MPI, and variations on it, are widely used in consultations under Section 7 of the ESA on the effects of federal actions and will be similarly used to evaluate activities pursuant to this rule. The MPI is also used in other venues to determine baseline conditions, identify properly functioning condition, and estimate the effects of individual management prescriptions. While this assessment tool originally was developed to address forestry activities, NMFS intends to work with state, tribal, and other experts to facilitate its use in other ecological settings such as lakes, estuaries and urban settings.

Comment 51: One commenter objected that the conservation standard for PFC was "jeopardy" or survival, which is inadequate for ESA 4(d) rules and for recovery.

Response: PFC is not calibrated to provide for population persistence at some level less than full recovery, nor does NMFS believe that the best available science holds out the possibility of such an incremental approach to habitat conservation. Land and resource managers are required to demonstrate that their proposed activities will allow for the recovery of all essential functions of salmon habitat.

Comment 52: Several letters addressed the applicability of the "properly functioning conditions" concept to urban settings and questioned whether PFC could ever be attained in urban environments.

Response: It is widely recognized that urbanization alters the hydrologic behavior of once unpaved, undeveloped lands. Within this context, common goals for the management of urban landscapes include controlling stormwater runoff and protecting water quality. An urban watershed can become properly functioning if the ecological functions essential for listed salmonids within the watershed–such as storage, attenuation of peak flows, and water quality mitigation—can be restored by increasing watershed storage and providing buffers to attenuate water quality problems emanating from urban landscapes. In this context, the PFC goal is to restore the hydrologic function in the urban watershed by modifying peak flow events, providing storage, protecting water quality and habitat, and allowing passage.

Comment 53: One commenter stated that the draft VSP concept and NMFS' established PFC approach were inconsistent.

Response: The VSP concept is being developed to serve as a population management analog to PFC's role in evaluating habitat-affecting actions. The intent of VSP is to serve as a consistent conservation standard, equivalent to PFC, that can be applied in diverse analyses. The VSP emphasizes measurable fish population parameters because that is how fish harvest and culture activities' environmental effects are most immediately and evidently expressed. Conversely, PFC indicators are typically physical habitat characteristics because they most readily and measurably show the effects of land and water management regimes. In essence, PFC is a description of conditions that support salmonid productivity at a viable level. However, because the standards are applied at widely different geographic scales, NMFS cannot currently describe the quantitative relationships between fine-scale habitat characteristics and salmon population levels. Though the two approaches measure effects on different salmonid biological requirements, they consistently strive toward the same end: determining the effects of various activities, placing them in the context of the species' life histories, and using that data to ascertain the best means of recovering the salmon.

Legal/National Environmental Policy Act (NEPA)/Reg Flex/Direct Take

Comment 54: Commenters asserted that the proposed rule exceeds NMFS' authority, either by reaching too far in protections or failing to meet ESA mandates by not being protective enough. Many commenters raised questions about the legal standards underlying limits and about the relationship between section 4(d) and section 7 consultations or section 10 habitat conservation plans. Several asserted that the standards for all three functions should be the same; others emphasized that the standard for 4(d) is more protective, stating that it must conserve the listed species.

Response: Many of those comments focus more on the limits provided than on the legally enforceable outcome of the rule (the take prohibitions). This response will first set forth in a general fashion the basis for this final rule, and then respond to the remainder of legal issues that are not included in the overall description.

First, section 4(d) regulations are those "necessary and advisable to provide for conservation" of the threatened salmonids. This final rule imposes one major regulatory prohibition (in addition to the less significant prohibitions of section 9(a)(1) or interstate commerce and import/export): that is, that actors are to avoid taking threatened salmonids of the 14 listed ESUs. The take prohibitions are what the ESA imposes by statute to protect endangered species and, if perfectly implemented, would provide the most protection possible. There is no question but that take prohibitions "provide for the conservation" of the species.

Nor can there be any real question about the advisability of imposing take prohibitions at all. NMFS' listings were based on findings that the ESUs are at risk and specifically that there are factors (set forth in ESA section (4(a)(1)) that have caused and are continuing to cause the listed ESUs' populations to decline. See "Factors for Decline: A Supplement to the Notice of Determination for West Coast Steelhead" (NMFS, 1996); Coastal Coho Habitat Factors for Decline and Protective Efforts in Oregon" (NMFS, 1997), and "Factors Contributing to the Decline of Chinook Salmon: An Addendum to the 1996 West Coast Steelhead Factors for Decline Report" (NMFS, 1998). Many of these factors (habitat destruction, overutilization, inadequate regulatory systems) are state, local, or private, and have no link to Federal actions. Prohibiting take for these ESUs is, therefore, the most direct way of protecting the listed species. NMFS listed two additional chinook ESUs as threatened in September of 1999 and will be proposing ESA 4(d) protections for them in the near future.

This final rule also establishes 13 circumstances in which NMFS does not find it necessary and advisable to apply the take prohibitions. NMFS believes that by describing (wherever possible) a program or the components of a program that will adequately protect the species, it provides valuable guidance to agencies or individuals wishing to play a part in salmonid protection and will minimize their legal risks under the ESA as well. NMFS further believes that it is appropriate to limit the take prohibitions for such programs provided that NMFS' salmonid conservation goal (and legal responsibility) is not compromised—that is, so long as the rule provides for conservation of the listed ESUs. Thus, this final rule limits the application of the take prohibitions selectively. NMFS is confident that given the stringency of the fish protections in the programs receiving limits on the take prohibitions, this final rule meets the section 4(d) conservation standard.

In determining that take prohibitions are not necessary and advisable for a particular program, NMFS has ensured that each program—including programs that NMFS will evaluate in the future to determine whether they fit within one of the 13 limits—will not jeopardize the species. That is, none will appreciably reduce the likelihood of survival and recovery of any of the ESUs in the wild.

Further, for some programs involving sectors which have had particularly destructive impacts on habitat or bear other significant responsibility for decline of the species, there must be a demonstration above and beyond "not jeopardizing." Just as a Federal agency has a responsibility not only to conduct its affairs in a way that does not jeopardize but also to use its authorities in furtherance of the conservation of the species, ESA 4(d) regulations as a whole must provide measures necessary and appropriate to conserve the species. Hence, while for many actions or programs "not jeopardizing" may be equivalent to not precluding or impairing recovery, for others it may be necessary to include commitments for specific positive contributions that are vital to recovery because of past impacts from those sectors. NMFS has taken those considerations into account when evaluating potential programs (or establishing approval criteria) to determine if they qualify for inclusion in one of the limits.

By statutory definition, species conservation equates to those methods and procedures that will bring a species to the point at which it no longer needs the protections of the ESA and may be delisted. Those methods and procedures encompass the full array of actions that will contribute to recovery: Federal efforts to avoid jeopardy and conserve the species under section 7; efforts taken in accord with section 10 conservation plans; state, tribal, local, or private initiatives undertaken to improve the prospects of listed fish quite independent of any ESA requirement; efforts to avoid taking listed species; and habitat improvements accomplished under numerous regulatory programs for protecting other resources, such as the CWA, state and Federal regulations governing fill and removal in waterways, and the like.

NMFS believes this final rule reflects the necessary and appropriate level of protections for conserving these threatened ESUs given our current knowledge. As the preamble to the proposed rule noted, NMFS recognizes that new information may lead to changes in the final rule. NMFS has not yet completed recovery planning for the species subject to this final rule, nor does the ESA command that recovery planning precede enactment of 4(d) regulations. Once recovery planning is complete, NMFS may amend the 4(d) protections with any combination of new or amended limits, impose the take prohibitions if a limit were found not to be consistent with a necessary and appropriate recovery measure, or require enhancements or prescriptions.

Comment 55: A few commenters asserted that NMFS gives no indication that it intends to comply with ESA sections 7 or 10 in promulgating or implementing these rules.

Response: Promulgation of a section 4(d) rule is a Federal action requiring consultation under section 7 of the ESA. NMFS must ensure through its internal consultation process that the 4(d) rule being promulgated is not likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of their critical habitat. NMFS completed the required consultation and concluded that promulgation of this rule greatly improves protections for threatened salmonids and their habitat, and is not likely to adversely affect either those ESUs or other listed species. NMFS has complied with its section 7 consultation requirements.

Where take prohibitions are imposed, those pursuing actions that may take listed salmonids may choose to apply for a section 10 permit at any time. Section 10 permits are issued on a case-by-case basis supported by individual analysis and section 7 consultation. Where NMFS has found it not necessary to impose take prohibitions, there would be no basis for issuing research or enhancement or incidental take permits through section 10, provided the action is carried out in accordance with the requirements of the applicable limit.

Comment 56: One commenter urged that NMFS make clear that no state or local rule shall hinder NMFS or citizens from taking legal actions to ensure salmon recovery. Another asked that NMFS provide for citizen enforcement and appeal of local government permits re ESA issues. A third commenter suggested that the limits be revised to reflect the idea that they extend only so far as local governments' reasonable interpretation and application of its own rules.

Response: This final rule does not in any way alter the ESA's enforcement provisions, including the rights of third parties to enforce under appropriate circumstances. Second, NMFS believes the proposed rules clearly established that in any enforcement proceeding where there is a question whether an action is "in compliance with" one of the described limits, it is ultimately the defendant's (or respondent's) responsibility to assert that issue as an affirmative defense and establish facts that show compliance. In order to dispel any confusion by the public on this point, NMFS has added a subsection, "Affirmative defense," to spell out that it will be the defendant's or respondent's obligation to plead application of and compliance with a limit as an affirmative defense. This approach is consistent with the structure of the proposed rule and with ESA section 1539(g) which states "In connection with any action alleging a violation of section 1538 [the section 9 prohibitions] of this title, any person claiming the benefit of any exemption or permit under this chapter shall have the burden of proving that the exemption or permit is applicable, has been granted, and was valid and in force at the time of the alleged violation." NMFS anticipates that in most cases, the applicability of individual limits will be resolved early in an enforcement investigation. Enforcement personnel will make reasonable efforts to attempt to rule out the applicability of 4(d) limits by, for example, evaluating circumstantial evidence, or through direct contact with the potential violator and subsequent confirmation through reliable third party sources. However, ultimately it is not the agency's responsibility to determine the existence or nonexistence of every exculpatory fact relating to an alleged ESA violation. This clarification is also consistent with existing case law, which generally holds that the burden of raising and proving affirmative defenses rests with the defendant, not with the government (see, e.g., *Patterson* v. *New York*, 97 S.Ct. 2319 (1977)).

As to the third comment, once a state or local government program comes within a limit (for instance, local development ordinances found by NMFS to meet the standards of the rule), it will be up to the local government to implement that ordinance, including any necessary exercise of reasonable judgement. If monitoring or other information indicates that the ordinance, as implemented, is not providing adequate protections, then the adaptive mechanisms in the 4(d) rule will trigger changes in the ordinance, imposition of the take prohibitions, or imposition under the ESA of affirmative requirements.

Comment 57: One commenter suggested that the standards set in the 4(d) rule to qualify for a limit are higher than landowners would otherwise be required to meet to avoid take. Another stated that there was no consistent conservation standard applied in evaluating potential limits.

Response: NMFS must respectfully disagree. The limits described in this final rule do not in every circumstance avoid all take. To do so would require much more stringent steps in some cases. Rather, the limits reflect NMFS' judgement that activities in compliance with such a program or approach are what current information indicates will be necessary and advisable for that activity sector to conserve the ESUs. Activities in compliance with such a program or approach will not appreciably reduce the likelihood of survival and recovery of the species in the wild and, where necessary, will include other conservation measures to repair or improve conditions. Nonetheless, it is expected—and in some cases demonstrable—that activities satisfying the conditions for inclusion within one of the limits will still take listed salmonids.

In evaluating fishery management programs to determine if they qualify for a limit, NMFS relies on the concept of viable salmonid populations and its associated use of viable and critical thresholds for management decisions. The limits require that relevant biological parameters be identified so individual population status can be evaluated and the program may be placed in an appropriate context for determining whether it will support population viability. Land management related programs being considered for limits are assessed according to their ability to help attain or maintain properly functioning conditions (i.e., those conditions NMFS considers necessary for supporting viable salmonid populations).

Comment 58: Several commenters noted that NMFS had not made the case that take prohibitions (or any ESA 4(d) rules) are needed for these ESUs, or for specific sectors of activity. Some assert that NMFS should first demonstrate that conservation activities applicable to Federal activities have been fully tapped before applying 4(d) rules to private lands.

Response: NMFS must respectfully disagree. While the contribution of non-Federal actions to the overall decline of the ESUs affected by this final rule varies, depending in part on the ratio of Federal to non-Federal lands and in part on the concentration of habitat modifications and non-Federal hatchery or harvest impacts, NMFS could not justify placing all hope of sustaining and recovering these ESUs on Federal agency actions alone. The record upon which NMFS listed these ESUs is abundantly clear that the decline of the ESUs is substantially influenced by actions other than those with some Federal nexus. While section 4(d) provides the Secretary some discretion in determining what protective regulations are necessary and advisable in a given circumstance, the structure of the section strongly supports the appropriateness of a determination to impose take prohibitions.

Comment 59: At least one commenter, while agreeing that the limits are not prescriptive rules, states that the rule making record does not support "this wide-ranging prescriptive rule" which the commenter believes prohibits "a very wide variety of activities that might occasionally "take" listed species" without NMFS' permission.

Response: To repeat the preamble text from the proposed rules, "[t]he fact of not being within a limit would not mean that a particular action necessarily violates the ESA or this regulation." NMFS has attempted to make even clearer in this final rule that activities that are not within a limit are not prohibited. What is prohibited is taking a threatened salmonid through any activities not within a limit. Those conducting activities that are not within a limit are subject to liability only if it can be demonstrated that their activities in fact have taken a threatened salmonid. An actor believing that its actions result in incidental take may apply for an incidental take permit under ESA section 10 to ensure that no enforcement liability accrues.

Comment 60: Two commenters noted that they had requested the decision-making record (for the proposed rule) and were told that it was "unavailable for public review."

Response: Both proposed 4(d) rules included a "References" section that offered a list of the references relied on. These documents were available to the public. That is all that informal rulemaking requires.

Comment 61: A few commenters noted that it is inconsistent with the ESA to apply the "jeopardy" standard (to not appreciably reduce the likelihood of survival and recovery in the wild) in a 4(d) rule; also, doing so for tribal plans is inconsistent with the standard applied for other "exemptions." One commenter urged that NMFS model all of the limits after the limit for tribal plans, which provides a process for NMFS to determine a plan's consistency with ESA standards, but does not set out specific requirements or standards.

Response: NMFS believes that none of the limits will jeopardize the listed species' survival or recovery and that each habitat-related limit will contribute to placing habitat on a trajectory toward proper function and populations on a trajectory toward viability. It is worth noting that in practical application, distinctions between what is needed for survival and recovery and between providing for recovery and not jeopardizing the likelihood of survival and recovery are speculative at best and perhaps specious. The limit for tribal plans applies that same standard but without specific requirements or standards, in deference to tribal sovereignty and the government-to-government basis on which NMFS interacts with tribes. It is important to note that while there is less specific guidance with respect to tribal resource management plans, they will be assessed against the fundamental ESA standard (whether they will appreciably reduce the likelihood of survival and recovery in the wild), as have the other limits, and that any determination regarding tribal resource management plans will be accompanied by a description of the biological rationale for its outcome.

Comment 62: One commenter believed that the ESA 4(d) limits are "negotiated," "second class" HCPs appropriate only to larger governmental entities and that they consign jurisdictions with smaller population bases to the fringes of the process. Another urged that all limits should be drafted so that they are made available to any government wanting to participate and get coverage under the limit.

Response: While NMFS does not agree with the commenter's characterization of the limits, we have broadened some of the limits' availability and modified others in such a way that they are more adaptable for smaller or more rural jurisdictions. For instance, the development limit no longer targets only to "urban density" development, and the road maintenance limit is available to any jurisdiction. These sorts of adjustments are the very heart of the 4(d) limit process—they illustrate NMFS' intention to create an open process of public review and adapt our proposals (when we may) in accordance with the feedback we receive.

Comment 63: One commenter suggested that NMFS should create "categorical exclusions" for activities not requiring the ongoing review and monitoring required in the proposed rules. The commenter points to FWS regulations that permit the Utah prairie dog to be taken under Utah state permits.

Response: In this final rule NMFS has made a number of adjustments to make limits more broadly available and to minimize requirements for oversight. However, the prairie dog provision the commenter cites makes very clear that if those takings interfere with conserving the species, FWS may immediately prohibit further such takings. Similarly, NMFS believes that the level of "tracking" required in this final rule will ensure that impacts from non-prohibited activities are consistent with conserving the threatened salmonids.

Comment 64: Some commenters asserted that the "proposed requirement" for protecting flows for listed species should be addressed in a local government's ordinance is beyond the scope and authority of a local government.

Response: Evaluation consideration "J" for the MRCI limit asks that the local government ordinances ensure that [new] development-related water supply demands can be met without impacting flows needed for threatened salmonids. This request does not require local government to regulate water rights or otherwise control flows; it asks only that new development demonstrate that its new water demands can be satisfied without undercutting flows required by threatened salmonids.

Comment 65: One commenter suggested NMFS should delegate to state and local officials authority to limit the take prohibition or provide a "certificate of safe harbor." Another commenter suggested that ESA section 9 take prohibitions cannot apply within a state unless the state has also adopted those regulations. This comment relies on the reference within 4(d) to section 6(c)(" ...such regulations shall apply in any State which has entered into a cooperative agreement pursuant to section 6(c) of this Act only to the extent that such regulations have also been adopted by such State").

Response: The approach NMFS takes in this final rule aims to recognize and encourage state and local programs wherever NMFS finds them adequate. Nothing within the ESA would give NMFS the authority to delegate the functions suggested, unless a state had the full set of authorities required under section 6 of the ESA for state "assumption" of a program. No state has as yet met those qualifications, which would include having all authorities necessary to conserve the listed species (such as the ESA provides through section 9, etc.). Therefore, the cited text of section 4(d) does not apply.

Comment 66: Another commenter suggested NMFS lacked authority to "delegate" scientific research permit authority to the states.

Response: As discussed in response to an earlier comment, this final rule does not delegate permit authority to states. For a subset of all research activities, this final rule does not apply take prohibitions, leaving those research activities subject only to state permitting. For other research, ESA constraints are still in place and researchers should seek ESA section 10 permits (for instance, for research in which private parties intentionally take listed fish.)

Comment 67: Several comments assert that the ESA 4(d) rules will result in takings of private property. One asked that the rule provide greater flexibility for redevelopment to prevent takings of private property.

Response: The legal effect of this final rule is to prohibit take of threatened salmonids. Complying with that mandate will certainly cause some changes in land management and use and that may affect the economic value of certain activities on the land to a greater or lesser extent—depending on the circumstance. This final rule does not, on its face, prohibit property use in any way that would rise to the level of a constitutional taking, nor does NMFS believe that the adjustments necessary to avoid taking threatened salmonids will be so draconian as to amount to a constitutional taking in any case.

Although NMFS does not agree that this final rule would likely cause a constitutional taking of property, NMFS did intend that the development limit should be broadly available and has amended and clarified the regulation to accomplish that purpose, including specifically naming redevelopment as one of the activities that individual ordinances could cover within the limit.

Comment 68: Many commenters desired that NMFS clarify the status of the limits: either wanting to be sure they are not prescriptive, or believing they should be hard requirements. Commenters also wanted to know if activities outside a limit constituted a violation of the rule.

Response: The limits are not prescriptive. They are not even enforceable requirements; rather, an entity wishing assurance that its actions are consistent with the ESA may take the necessary steps—as outlined in the regulations—to come within a limit on the take prohibitions. No enforcement action can be taken based on a charge that someone has failed to follow a limit. Enforcement actions must allege (and ultimately prove) that a listed fish has been taken.

NMFS understands that some commenters would prefer the agency to promulgate specific, detailed regulations to govern particular sectors of activity. For a variety of reasons, NMFS has not chosen that course at this time. Specific proscriptions are an effective protective mechanism where, as with threatened sea turtles, a very specific cause of mortality can be addressed with precision. In the case of Pacific salmonids, where impacts are caused by a large array of activities and where the circumstances leading those impacts to constitute a take are extremely site- or circumstance-specific, NMFS believes it extremely difficult to design a single set of prescriptive rules to cover all of those situations. In addition, prescriptive regulations would likely impose unnecessary costs on some individuals. This is because state, local and individual strategies for avoiding take can be more closely adapted to the local geography or fishery opportunities than can rules that cover an entire landscape. Thus they are equally as effective (or more so) at avoiding take of listed species and less costly than regionwide, blanket prescriptions. The approach taken in this final rule, recognizing limits but not requiring all entities or actors to be within a limit, offers an opportunity to test particular combinations of approaches without requiring everyone to invest in them immediately. Finally, as noted elsewhere in these responses, once recovery planning is complete it may identify specific areas needing more prescriptive attention.

Comment 69: Numerous comments suggested that the rule intrudes impermissibly on state water law. Commenters questioned NMFS' understanding of western water law and authority to regulate water.

Response: First, as discussed elsewhere, this rule does not directly regulate water use or water rights in any way. Rather, water diversion was identified as an activity likely to result in take under particular circumstances. There is nothing in the ESA that would carve water use out of the bundle of activities that might lead to an enforceable take of salmonids, nor that would excuse senior water users from responsibility for any take that occurs as a result of their actions. NMFS does not disagree that on a case-by-case basis, questions or priority may be germane to determining causal responsibility for particular impacts. In "A Citizen's Guide to the 4(d) Rule" (NMFS, 2000), NMFS provides more information on how water users may evaluate the level of risk of take associated with their diversions and explores options for reducing that risk.

Comment 70: One commenter asked NMFS to clarify whether ESA section 7 compliance "is a substitute for" compliance under the rule. Another requested that NMFS include an explicit limit for any entity whose actions have been the subject of an informal consultation in which NMFS has concurred that the action is not likely to adversely affect the threatened species.

Response: Section 7 compliance is an adequate substitute for compliance under this rule. So long as an entity is acting within a completed formal ESA section 7 consultation and compliant with terms and conditions imposed, if any, then section 7(o)(2) provides an exception to the prohibitions on taking. Actions subject to informal consultation have a very low probability of take and are thus in the category of activities that do not need to pursue a limit.

Comment 71: Take prohibitions should be applied to California's Central Valley, especially the Yuba River area.

Response: The Central Valley steelhead ESU is subject to this final rule. NMFS expects to propose ESA 4(d) protections for the Central Valley spring chinook ESU (listed in September of 1999) within the coming months. Meanwhile, that ESU will benefit from habitat protection afforded by steps taken to avoid taking Central Valley steelhead.

Comment 72: One commenter stated that contrary to the Executive Order on Federalism (E.O. 13132), this final rule's intervention (monitoring and reporting/adjustment of limitations) in state and local land use governance exceeds NMFS' authority by unnecessarily infringing on state sovereignty. Another suggested that the final rule should state that NMFS is not requiring consistency between state and local regulatory programs and objectives of the ESA.

Response: NMFS does not agree that this rule intrudes upon state or local authorities or sovereignty. This rule does not require states to undertake any particular set of actions. It requires that states (like all other actors) refrain from taking threatened salmonids. It provides one mechanism that actors (including states for some of the limits) may pursue to ensure that they do not violate take prohibitions. A state could instead choose to pursue ESA section 10 permits. Where there is a Federal nexus, state actions may receive ESA scrutiny and legal assurance through an ESA section 7 consultation initiated by the action agency. Or, in appropriate cases, a state may determine in its own judgement that particular activities do not carry a risk of taking listed fish, or it may modify its activities in such a way as to reduce any risk of take to an acceptable level.

Comment 73: One commenter argues that the VSP paper is inconsistent with the statutory requirements of the ESA, because of the statement in the preamble to the proposed rules that a "viable population threshold refers to a condition where the population is self sustaining, and not at risk of becoming endangered in the foreseeable future." The commenter suggests this implies a threatened species can be allowed to remain in threatened condition perpetually, and still be considered viable.

Response: The commenter has identified an imprecise characterization that was included in the preamble to the proposed rules. This statement has been removed. As explained in response to other comments on VSP, the VSP paper does not attempt to define "threatened" or "endangered" under the ESA.

Comment 74: Some commenters stated that NMFS is abusing its discretion by not invoking section 9 prohibitions, and instead relying upon promised conservation efforts and future actions that are not currently operational.

Response: This final rule relies upon a determination that a conservation program approved for a limit of the take prohibition has a high degree of certainty that it will be implemented. NMFS may require a commitment to mitigate if implementation of a program is terminated prior to completion.

Comment 75: One commenter asserted that NMFS should not or cannot incorporate guidance by reference unless it has undergone ESA section 7 analysis.

Response: First, because of modifications made in response to comments, this final rule incorporates far fewer documents by reference. Second, while there is no requirement for a section 7 consultation on such documents, those referenced in the final rule have been analyzed to ensure that actions under them will not appreciably reduce the likelihood of survival and recovery of the listed ESUs in the wild.

Comment 76: One commenter wanted the rules modified to prohibit Federal agencies from activities that "take" threatened salmonids.

Response: In most cases this final rule does not specifically address Federal agency actions. Once take prohibitions are in effect, they apply to all actors—Federal and non-Federal alike. Second, the ESA requires that Federal actions be assessed under section 7(a)(2), and nothing written in a 4(d) rule would excuse that obligation. Once NMFS has issued a biological opinion and incidental take statement for Federal agency actions, section 7(o) of the ESA relieves the agency of liability for take.

Comment 77: One commenter asserted that the rules could make the controllers of certain activities (such as noxious weed control) vulnerable to third-party lawsuits. Commenters expressed concern about municipal and irrigation district liability for issuing permits that result in take. One commenter stated that municipal entities cannot be held liable for take if the entity does not have discretion in issuing a permit.

Response: The first commenter is correct that under the ESA the take prohibitions are enforceable by NMFS or by third parties. This final rule does not create any enforcement routes not specified in the ESA. The take prohibitions apply to all actors, so municipalities and irrigation districts certainly face the possibility of liability; actual liability would depend on specific factual circumstances and the degree of connection between the permit and the take that actually occurs. As to the suggested legal interpretation that a municipal entity's lack of discretion in deciding to issue a permit would be an absolute defense to liability, NMFS believes that question must be addressed in the specific enforcement context in which it arises.

Comment 78: One commenter noted that in cases where documents create new legal rights or duties, they are considered "substantive rules" and must be either published in the **Federal Register** or be incorporated by reference through the Director of the Federal Register. Therefore, NMFS should clarify how subsequent amendments to these referenced documents will be treated.

Response: There are seven documents referred to in the regulatory text of this final rule. The purpose of making these documents available to the public is to inform governmental entities and other interested parties of the technical components NMFS expects to be addressed in programs submitted for its review. These technical documents provide guidance to entities as they consider whether to submit a program for a 4(d) limit. The documents represent several kinds of guidance, and are not binding regulations requiring particular actions by any entity or interested party. NMFS will continue to review the applicability and technical content of its own documents as they are used in the future and make revisions, corrections or additions as needed. NMFS will use the mechanisms of this final rule to take comment on revisions of any of the referenced state programs. If any of these documents is revised and NMFS relies on the revised version to provide guidance in continued implementation of the rule, NMFS will publish in the **Federal Register** a notice of its availability stating that the revised document is now the one referred to in the specified 223.203(b) subsection.

Comment 79: One commenter suggested that NMFS clarify the regulation regarding withdrawal of a take limit, believing those in the proposed rule to be unnecessarily harsh.

Response: NMFS has modified the language throughout this final rule to clarify this point.

Comment 80: One commenter stated that the final rule should be non-severable, so that if any or all limits are overturned in a legal challenge, the take prohibitions will not remain in effect. Another suggested that no take prohibition should be imposed until broad limits are available for virtually all sectors of human activity.

Response: A fundamental precept of this final rule is NMFS' determination that the subject ESUs require 4(d) protections. Given that, it would be inconsistent with NMFS' ESA responsibilities to the threatened fish to defer any protections in that manner. NMFS has clarified this point by making it explicit that the agency intends the provisions of this rule to be severable.

Comment 81: Because NMFS broadly applies PFC as standards with a regulatory effect, PFC guidance and supporting science should be subject to public notice and comment before it is formally applied to ESA 4(d) limitation approvals.

Response: PFC requires the maintenance of habitat functions essential to the survival and recovery of listed salmonids. As such, the use of the PFC approach as an analytical tool adds no standard to that already established in the ESA, but rather assists NMFS and the users in evaluating effects of activities on conservation of the species.

Comment 82: One commenter asked NMFS to clarify whether the take prohibition applies throughout the range of the ESUs or only in designated critical habitat. Another asserted that NMFS has created a de facto extension of critical habitat.

Response: The take prohibition applies throughout the range of the affected ESUs. Critical habitat designation gives guidance to Federal agencies, and is not directly linked to ESA section 4(d) in any way. As to the assertion that the rule creates "de facto" critical habitat, NMFS must respectfully disagree. Contrary to the commenter's perception, this rule does not suggest that "highly burdensome and expensive 'safe harbors' are what it takes to avoid ESA section 9 take liability." The rule provides one method of ensuring that no ESA section 9 take liability accrues, but there are other methods such as section 10 permits. Or, an actor may determine in its own judgement that particular activities do not carry a risk of taking listed fish, or modify its activities in such a way as to reduce any risk of take to an acceptable level.

Direct Take

Comment 83: Some commenters contended that under the ESA, and court decisions interpreting it, NMFS does not have the discretion to "allow" or "authorize" direct take of listed species through 4(d). The commenters cite cases in which the courts have determined that FWS could not authorize hunting of threatened wolves or grizzly bears unless it had first determined that "population pressures within the animal's ecosystem cannot otherwise be relieved."

Response: In these rules the Secretary is making an initial determination as to what protective regulations are "necessary and advisable to provide for the conservation of" the listed salmonids. In making that determination, the Secretary is not required to impose take prohibitions. In fact, section 4(d) goes on to state that "[t]he Secretary may by regulation prohibit with respect to any threatened species any act prohibited under section 9(a)(1)..." Thus, the Secretary has discretion to assess the status of the listed ESUs and to determine, as he has here, that blanket application of the take prohibitions is not necessary and advisable, and to describe the circumstances in which take prohibitions will not be applied. The Secretary has found that in certain circumstances, activities are sufficiently regulated by other entities or processes that Federal take prohibitions are not necessary and advisable.

In a variety of circumstances, take prohibitions might not be found necessary and advisable to provide for the conservation of a threatened species. For instance, if a threatened species is located almost exclusively on Federal lands and impacted largely by a Federal activity on those lands, the Secretary might determine that section 7 consultations will provide all the protections necessary to allow the species to recover. Or, a threatened species might be threatened because of negative impacts from a narrow class of human activity. In that circumstance, the Secretary might choose to impose prescriptive regulations tailored specifically to alter those activities in a manner that would allow the species to recover.

More importantly, the biological impact of take on the ESU is the same, whether a particular number of listed fish are lost as a result of incidental impacts or intentional (directed) impacts. Situations in which this final rule would limit the application of take prohibitions for intentional taking of threatened salmonids are extremely limited and consistent with the conservation and recovery goals of the ESA. Scientific research activities conducted by fisheries experts, in accord with specific guidance, and permitted by a state, can be within the limit. Harvest activity will have direct impacts in very few situations—generally where the status of the affected population is already considered viable, even though the status of the larger ESU is not. Taking listed broodstock for artificial propagation might occur for conservation purposes (or, only after the species' conservation needs are met, for secondary purposes such as fisheries).

Comment 84: A few commenters stated that in excusing direct take through harvest, NMFS is placing a far more demanding burden on other sectors (such as land use) in terms of minimizing and avoiding incidental take. They asserted that the demands/standards should be equivalent.

Response: This final rule is far from "excusing direct take through harvest" in any blanket fashion, as the comment may be read to suggest. Rather, in setting out the standards by which any fishery harvest program will be judged, NMFS has emphasized the means by which a management scheme maintains or achieves viable status for a population rather than on the specific mechanism by which that impact may be incurred. This final rule does not give a pass to any specific management plan at this time; each plan must be made available for public comment and reviewed against the standards for an Fishery Management and Evaluation Plan (FMEP). NMFS anticipates few instances, especially in the early stages of recovery, where such plans will include impacts targeted on threatened salmonids.

The standards by which NMFS will judge the suitability of any program for a limit are the same, whether the program manages fishery harvest or some type of land management activity. In both instances, such a program may have some impact on the listed ESU, but at a level that will not appreciably reduce the likelihood of its survival and recovery in the wild. Because current habitat conditions are in most cases far below those needed to support viable populations in the wild, additional impacts on habitat must be carefully constrained and in many cases, accompanied by mitigative measures.

Comment 85: One commenter stated that the proposed rule does not (but should) address commercial harvest and noted that NMFS recently increased the allowable commercial take of salmon which will unavoidably include some listed fish.

Response: The prohibition against take applies to all activities subject to U.S. jurisdictions, including commercial, recreational, and tribal harvest. The commenter refers to commercial harvest in the marine context, which is evaluated through section ESA 7 consultations. Any commercial activity in non-ocean fisheries would have to be governed by an FMEP in compliance with all of the standards of these rules.

NEPA

Comment 86: Some commenters wanted NMFS to clarify the extent to which NEPA applies to the ESA 4(d) rules.

Response: NEPA applies to the ESA 4(d) rules and, as the proposed rule states, NMFS completed environmental assessments (EAs) for this action. Those EAs were made available upon request and on NMFS' web site during the comment period.

Comment 87: Several commenters suggested that the EAs failed to examine a full range of alternatives (such as the Oregon Plan) or that they did not adequately discuss and evaluate the impacts of the proposed action.

Response: While none of the alternatives focus specifically on the Oregon Plan by name, Alternative B contemplates that a state "would have developed a fully adequate comprehensive salmon conservation plan ...to ameliorate all factors for decline for ...an ESU." The EA assesses what impacts a fully adequate plan would have on the environment, assuming that NMFS recognized such a plan by not applying the take prohibitions to actions in conformance with it. NMFS has reexamined the EAs in light of these comments and believes they explored an appropriate set of alternatives.

Comment 88: One commenter noted that NEPA requires a quantitative assessment of consequences of the proposed rule and that agencies should ensure the scientific integrity of discussions and analyses in NEPA documentation—including explicit reference to the sources relied upon in making the determination.

Response: The comment would be appropriate to an Environmental Impact Statement (EIS). However, an EA should not contain long descriptions or detailed data. Rather, it should contain a brief discussion of the need for the proposal, alternatives, and the environmental impacts of the proposed action and the alternatives. Hence, NMFS believes the level of detail provided is adequate for an EA, which is expected to be a concise, brief document.

Comment 89: Some commenters asserted that the ESA 4(d) rules will allow significant negative impacts from logging, water withdrawal, agriculture, etc. to continue; hence, NMFS should draft an EIS disclosing these significant impacts. Others stated that the simple act of proposing the 4(d) rules required documentation in an EIS and that the final rules should be delayed until such an EIS has been written.

Response: While such activities may have significant negative impacts on the human environment, they do not occur as a result of the ESA 4(d) rules. The comment argues for regulations that will reduce those negative impacts. As the EAs reflect, the take prohibitions will do that. While the commenters may question whether the take prohibitions are the best tool for reining in those negative impacts, the final 4(d) rules as written do not cause any of those impacts. Therefore, no EIS is required for the 4(d) rules.

Take prohibitions are the sole legally enforceable component of these 4(d) rules, and will impact the environment in a positive manner, phasing in over a long period of time (especially with regard to habitat impacts). The Council of Environmental Quality regulations make clear that the fact that an action will have net beneficial environmental impacts does not excuse preparation of an EIS where there are also significant negative impacts (40 CFR 1508.27—definition of "significantly"). In this case the EAs reveal no significant negative environmental impacts, and NMFS believes the EAs satisfactorily address NEPA. Economic impacts need be evaluated only when required as part of the process of preparing an EIS, not as a reason for doing one. (See 40 CFR 1508.14, "This means that economic or social effects are not intended by themselves to require preparation of an environmental impact statement. When an environmental impact statement is prepared and economic or social and natural or physical environmental effects are interrelated, then the environmental impact statement will discuss all of these effects on the human environment.") Finally, a belief that the take prohibitions do not go far enough to stop activities that harm the environment is not an argument for an EIS.

Comment 90: One commenter stated that NMFS incorrectly asserts in the EAs that all environmental effects resulting from actions that respond to the ESA 4(d) rule are the independent analytical burden of state and local governments and NMFS will not need to consider or address them. They further stated that NMFS must grapple with the environmental effects of its proposed actions, many of which will be negative for irrigation, noxious weed control, use of pesticides, livestock grazing, etc.

Response: NMFS agrees that this statement in the EAs should have been drafted more clearly. It must be read in the context in which it appeared. The immediately preceding sentence stated "In addition, any future regulation, policy, program, or plan that NMFS feels is protective of [listed salmonids] and for which NMFS limits the section 9(a) prohibitions, will further reduce the impacts of the 4(d) rule." In that context, the following modified statement would have been clearer: "All of the potential impacts attributable to any future limits will be due to those state or other governmental regulations, policies, programs, or plans, rather than to the 4(d) take prohibitions."

Economics/Regulatory Flexibility Analysis

Comment 91: Several commenters raised issues related to E.O. 12866, and stated that NMFS should do a cost/benefit analysis on the promulgation of this rule.

Response: NMFS has prepared a Regulatory Impact Review (RIR), which is available on our web site at www.nwr.noaa.gov. Some of the comments, however, were based on a misunderstanding of the legal effect of this 4(d) rule and were made in the belief that the rule mandated compliance with particular limits. That is not so; this 4(d) rule does not (for instance) mandate watershed conservation plans. This final rule provides a limit on the take prohibitions for habitat restoration activities consistent with watershed conservation plans that meet certain standards, but does not require any person or entity to prepare watershed plans or pursue that limit; they may avoid violating the take prohibition by whatever mechanism they choose.

Comment 92: One commenter stated that in addition to demonstrating how each limit contributed to recovery, NMFS should discuss economic and social impacts of each limit.

Response: It is NMFS' responsibility to assess the economic impacts of the regulation overall; those impacts accrue from the take prohibition, not from the limits. NMFS completed an initial regulatory flexibility analysis (IRFA) and made it available for public comment through the proposed rules. Based on comments received, NMFS has broadened many of the limits to make them available to more jurisdictions, or to simplify the processes associated with them. For instance, the road maintenance limit is now available to any state, city, county or port. The development limit is available for any city, county, or regional ordinances or plans that cover development, or categories such as wetland or shoreline regulation. NMFS has supplemented the IRFA to consider some additional categories of economic activity, such as real estate, as well. The Final Regulatory Flexibility Act concludes that at the present time there is no legally viable alternative to the modified rule that would have less impact on small entities and still fulfill the agency's obligations to protect listed salmon and steelhead.

Comment 93: One commenter stated that NMFS should (and failed to) consult with every state and local entity regarding effects of the rules on those entities.

Response: The huge number of such entities within the geographic range covered by this rule makes such consultation far beyond NMFS' resources. However, NMFS held 25 public hearings, accepted comment on the rules for 60 days, and after publishing the proposed rules, held three workshops for state and local government officials in Olympia and the Tri-Cities in Washington and in Salem, Oregon. More than 150 city, county, and state jurisdictions participated in these workshops.

Comment 94: One commenter stated that the IRFA was inadequate in its analysis of alternatives, and that it "fails to even list" the small businesses related to residential and commercial development in its Table of Sectors.

Response: NMFS stands by the IRFA and affirms that it presents as much information on the possible effects of the take prohibition as could be obtained through any reasonable means. Moreover, comments were solicited on the proposed rules, but NMFS received none suggesting additional sources of relevant data. The IRFA Table of Sectors included Heavy Construction and Highway and Street Construction, which would encompass a large proportion of the activity related to residential and commercial development. We have also added information on real estate and rental leasing to the Final Regulatory Flexibility Analysis. In addition, the RIR discusses the implications of the 4(d) rule in the urban setting—including activities associated with residential and commercial development.

Comment 95: One commenter stated that an independent third party should perform an analysis of the ESA 4(d) rules' economic impacts using economic information developed by the Federal Reserve. The commenter further stated that provisions for landowner compensation and exemption from property tax assessments must also be included as part of this rule.

Response: There is no requirement for third party analyses, nor that NMFS use information from any particular source in its analyses. In fact, NMFS has searched broadly for economic information that might provide more quantitative estimates of the potential costs of avoiding take. The Federal Reserve does not develop such data. NMFS has no authority to provide for landowner compensation or to alter property tax assessments. One of the reasons for the approach taken in this final rule is NMFS' hope that by working with local and state government entities toward comprehensive ESA solutions, there will be smaller impacts on individual actors than might accrue from take-avoidance strategies they might otherwise adopt. Also, as is the case for small landowners under the Forests and Fish Report strategy adopted by Washington and recognized in this final rule, in some circumstances local or state governments may elect to provide offsetting compensation.

Comment 96: Several commenters disagreed with aspects of the IRFA prepared for the proposed rules. A major concern was that the rule requires extensive reporting and paperwork.

Response: This final rule requires only one thing: that actors refrain from taking listed fish. That performance standard does not require reporting. While taking advantage of a limit does require some level of paperwork, that course is not required; an individual or entity may choose simply to modify its actions to avoid take. Nonetheless, NMFS is aware that in some circumstances the paperwork burden is likely to increase and we stand ready to help streamline the process, give technical advice, and in general decrease that burden wherever we can.

Recovery/Delisting

Comment 97: Many commenters raised issues regarding the timing of and relationships between ESA 4(d) rules and recovery planning. Several stated that NMFS should move forward quickly to develop recovery plans for listed species. Some requested that NMFS publish de-listing goals concurrent with the publication of the final 4(d) rules or withdraw the 4(d) rules until a recovery plan was complete. Related comments questioned whether, in the absence of recovery goals, NMFS could adequately assess the contribution to recovery made by the programs approved as limits on the take prohibition. Other commenters wondered whether the establishment of de-listing goals would require NMFS to reevaluate limits already approved or change the standards for evaluating additional limits. One commenter expressed concern that future recovery plans would simply "rubber stamp" 4(d) rules and their limits.

Response: Recovery planning, as required by ESA section 4(f), is one of NMFS' highest priorities, and NMFS agrees that it is important to move forward quickly to establish recovery plans for listed species. NMFS does not agree that it is either necessary or advisable to publish de-listing goals and final recovery plans concurrently with, or prior to, the final 4(d) rules.

There are no statutory or regulatory requirements regarding the timing or relationships between 4(d) rules and section 4(f) recovery plans. In fact, the basic structure of the ESA itself provides that the protective mechanisms of sections 7 and 10 take effect upon the listing of a species as threatened or endangered while recovery planning follows its course through subsequent activities. Recovery plans will provide biological goals for recovery and identify an entire suite of actions needed for recovery. Thus, they may provide a more specific framework for future 4(d) rules or amendments, but the essential protective function of 4(d) rules is independent of recovery plans; that function is to prohibit take of listed species where needed. If the 4(d) rules were not promulgated until de-listing goals were developed or recovery plans completed, the species would be placed at unacceptable risk, and more stringent and costly measures would be necessary to save them.

Moreover, by applying the VSP and PFC concepts it is possible to make judgments about the contributions certain programs make to recovery. These judgments will not prejudice the comprehensive recovery planning process.

For habitat actions, NMFS may find that it is not necessary or advisable to apply the take prohibition to programs that will help attain or protect properly functioning habitat. For FMEPs, NMFS may find it is not necessary or advisable to apply the take prohibition when the program contains specific management measures that adequately limit take and otherwise protect the ESU. For Hatchery and Genetic Management Plans (HGMPs), NMFS may find that it is not necessary or advisable to apply the take prohibition when a plan is designed to minimize and adequately limit take and promote species conservation. NMFS believes that these standards are all consistent with recovery, and expects that most programs approved as limits will provide a foundation for later recovery planning measures. NMFS also anticipates that the VSP and PFC concepts will continue to evolve and provide the analytical framework for evaluating potential limits and recovery measures.

Through the process of recovery planning, NMFS may develop more specific information about measures needed for recovery or about specific areas needing more prescriptive attention. In addition, each take limit incorporated into the 4(d) rules includes provisions for continued review of its implementation and effectiveness. Thus, NMFS intends to continually reevaluate the limits. If these evaluations, or information developed through recovery planning, or any other information, indicates that a limit is inadequate for recovery, NMFS will revisit the limit.

Finally, NMFS is moving forward as quickly as resources allow to develop recovery plans. NMFS has appointed Technical Recovery Teams (TRTs) for Puget Sound and for the Willamette/Lower Columbia River Basins and Southwest Washington. These teams have begun to identify delisting goals. To conduct the more policy-oriented aspects of recovery planning, NMFS will work with state, local, tribal, and private entities to craft a recovery planning process suited to specific areas and situations. Formal recovery planning efforts will be expanded to additional geographic domains as resources permit.

Comment 98: Several commenters addressed the issue of federal trust responsibilities to tribes in developing protection and conservation goals, plans, and measures. These commenters held that NMFS needs to make every effort to ensure that treaty rights and trust responsibilities are met through its regulatory actions, and that thresholds, goals, and recovery plans support healthy, productive, and harvestable fish populations.

Response: NMFS approaches the ESA 4(d) rules as a vital component of conserving the species until the protections of the ESA are no longer needed. These protections will no longer be needed only if the abundance of fish is sufficient to satisfy treaty fishing rights and to fulfill the trust obligations of the United States.

Cumulative Impacts

Comment 99: A number of commenters questioned the reasoning behind NMFS including in the take guidance a category of activities that, while individually unlikely to injure or kill listed salmonids, may collectively have significant detrimental impacts. Commenters asserted that regulating such activities was beyond NMFS' purview. Others questioned how NMFS would enforce the prohibitions when take resulted from such activities.

Response: NMFS agrees somewhat with this comment. The discussion of activities that do not cause take individually but that cumulatively may have significant detrimental impacts on salmonids was intended to be advisory and informative in nature and no enforcement actions in response on these activities were being contemplated. The category of activities raised a number of concerns however, and the language has been struck from the rule. Nonetheless, it is important to note that a myriad of decisions made by individuals and institutions on a daily basis, while negligible in the individual case, may have, in the aggregate, a significant detrimental impact on the ecosystem processes that support salmon and steelhead.

Comment 100: Many commenters raised the issue of cumulative impacts. Some expressed concern that the 4(d) proposed rules did not assess the cumulative impact of all the take limits combined. Some also expressed concern that the individual take limits did not address cumulative impacts of activities covered under that limit. Several commenters requested that the final rules include an analysis of cumulative impacts as well as a mechanism for evaluating cumulative impacts caused by any future take limits. One commenter asked how and when NMFS would provide opportunities for the public to review and comment on ESU-wide assessments of cumulative take.

Response: The suggestions regarding cumulative impacts have great merit, and NMFS is moving toward implementing a method for assessing total take across broad sectors. That function, however, would not be specific to the 4(d) context. Impacts on listed species accumulate from natural conditions as well as from illegal and unauthorized take and from actions to which the take prohibition does not apply because they fall in the realm of some other ESA mechanism (section 10 permits; section 7 consultations, or specific provisions of a 4(d) rule). Cumulative impact assessment is problematic because there are very few methods for adequately assessing cumulative impacts of habitat-modifying activities. Nonetheless, NMFS has explicitly incorporated consideration of cumulative impacts into the 4(d) rules where feasible. For example, FMEPs will evaluate the cumulative mortality of all fisheries, and HGMPs will track the number of listed fish taken as broodstock. In addition, NMFS believes that by requiring habitat-modifying activities within a limit to attain or maintain properly functioning condition, and all activities within a limit to contribute to viable salmonid populations, cumulative impacts are, to an extent, accounted for. Moreover, during the process of developing comprehensive recovery plans, NMFS and recovery teams will address the issue of cumulative impacts more systematically. The public will have the opportunity to comment on ESU-wide assessments of cumulative levels of take during the recovery plan public review process.

Comment 101: A number of commenters recommended ways for NMFS to assess cumulative effects. One commenter asserted that meaningful assessments of cumulative risk at the ESU level would require linkage between VSP and PFC and development of a common method for evaluating the effects various activities have on populations and habitats. Another urged that NMFS adopt comprehensive habitat productivity standards to evaluate cumulative effects of habitat programs granted limits on the take prohibition. One commenter suggested that NMFS require all habitat-modifying activities to account for habitat-modification-related mortality. Another suggested that NMFS focus on cumulative take rather than dealing with take in its various permutations individually. Another suggested that the rules should mandate an annual cumulative take assessment (based on life cycle stages) for each population in an ESU. In addition, they desired that NMFS (a) examine mortality in the various populations and determine whether take from a particular sector is placing them at risk, and (b) separate human-induced mortality from that attributable to fluctuating environmental conditions and thereby adjust take regulations to provide more protection during times of environmental stress.

Response: NMFS agrees that all of these suggestions have great merit and, as mentioned previously, NMFS is moving toward implementing a method for assessing total take across broad sectors. Also, as mentioned earlier, assessing cumulative impacts is a difficult process. In most cases, there are no adequate standards for habitat productivity and developing them is a complex and long-term task. NMFS intends to work with co-managers to develop the necessary standards and assessment techniques. In addition, during the ESA recovery planning process, NMFS will assess the mortality burdens for each ESU and life-cycle stage.

Comment 102: One commenter asserted that limits for urban development should be analyzed within the cumulative impact context.

Response: NMFS agrees that cumulative effects should be an important consideration in analyzing the effects of MRCI development and redevelopment. To the extent that NMFS must prioritize the evaluation process, comprehensive MRCI plans with relatively broader scopes of activities, authorities, effects, and geography (and therefore greater cumulative effects) will generally be evaluated before plans with relatively smaller scopes. Applicants with smaller-scale plans should take particular care that their effects analyses take cumulative impacts into account.

Comment 103: Several commenters questioned whether NMFS had completed requisite cumulative effects analysis under ESA section 7 and NEPA.

Response: NMFS has complied with section 7 consultation requirements on the adoption of the 4(d) rules by consulting both internally and with FWS. In addition, NMFS has completed an EA for this action pursuant to NEPA.

Comment 104: One commenter asserted that the cumulative impacts consideration required by § 223.203(b)(8)(iii)(A) is unreasonable due to lack of clear scientific consensus on how to do so.

Response: Cumulative impacts analysis has been routinely required by NEPA, ESA, and many other Federal and state authorities for several decades and NMFS does not believe it presents an insurmountable obstacle to development of acceptable watershed conservation plans (WCPs). In fact, it would be difficult to complete an adequate watershed analysis without having considered cumulative impacts. NMFS is confident that state WCP guidelines will be able to offer sufficient technical advice so that entities developing WCPs will be able to meet the cumulative impacts requirement.

Comment 105: Some commenters held that the rules failed to regulate activities consistent with their incremental effects, and that the effect of the rules would be to focus NMFS staff time on urbanized areas, while greater benefit could be gained by identifying habitat areas where the most good could be achieved at the least cost, and then bringing Federal, state, and local resources to bear upon those areas. Other commenters expressed concern that the rules would disproportionately regulate the impacts of habitat modification compared to the impacts of harvest activities.

Response: NMFS does not believe that the 4(d) rules fail to regulate activities consistent with their incremental effects. The 4(d) rules "regulate" primarily by putting into place the ESA section 9 take prohibitions. This take prohibition applies to all activities, regardless of their incremental impact on a listed species. The rules then identify certain activities that already conserve the species and for which no additional ESA regulation (i.e., take prohibitions) are necessary. These activities span a broad range and include research, aiding stranded salmonids, managing harvest and hatcheries, and land uses such as forestry, development, and road maintenance. NMFS hopes to continually expand the scope of these limits to encompass additional activities not currently addressed by limits, wherever such efforts are biologically warranted.

Limits for Scientific Research and Rescue/Salvage

Comment 106: Several commenters stated that the ESA 4(d) limit for scientific research activities (research limit) would place excessive reporting requirements on state fisheries agencies and that these agencies lacked the funding and staffing to accommodate the additional workload.

Response: NMFS acknowledges that, as a result of promulgating the take prohibitions, state fisheries agencies will now have a higher level of accountability for reporting take of listed salmonids and that some ESA-related reporting will be new for these agencies. However, all of the affected agencies currently oversee research permit processes for fish sampling in state waters and NMFS believes that the workload associated with this limit should be comparable with state reporting/recordkeeping requirements already in place. Much of the information NMFS is requiring under the research limit is currently generated by the state's permit process, which presently covers all entities (e.g., Federal, academic, private, and other state agency researchers) other than biologists employed by the state fisheries agency. However, these agency biologists typically produce research summaries that NMFS believes could be efficiently translated into the annual state reports supporting this limit.

Moreover, a major impetus for providing the research limit is to allow the state fisheries agencies to continue to oversee and coordinate research efforts for listed salmonids. The ESA's section 10 permitting process does not always facilitate state oversight/coordination and NMFS believes that it is advisable to minimize research impacts by streamlining the research review process in a manner that fosters active participation by state fisheries agencies. It is worth noting that as a result of previous 4(d) rulemaking (50 CFR 223.204(a)(4)), ODFW has successfully coordinated and reported scientific takings per a 1997 research limit involving listed coho salmon in southern Oregon. NMFS will work closely with all of the affected states and research entities to expand on this success while minimizing the reporting workload by incorporating existing state processes into those supporting the 4(d) limit for scientific research.

Comment 107: Some commenters asked whether research involving direct take of listed salmon and steelhead would still require a section 10 permit and whether incidental take would be covered under the ESA 4(d) rule.

Response: Research and monitoring activities involving either directed or incidental take of the 14 ESUs identified in this rule are covered by this 4(d) limit. Therefore, state-approved activities covered by this limit would not need to go through a separate section 10 permit process. However, if the research is not covered by the research limit, then an applicant would need to obtain an ESA section 10 permit before conducting research that could take a listed salmonid.

Comment 108: Several commenters were confused by the language describing provisions under "Continuity of Scientific Research" and requested clarification as to what applications were needed and when take prohibitions would become effective.

Response: As described in the proposed rules, NMFS is concerned with the potential for disrupting ongoing scientific research, monitoring, and conservation activities, especially during the coming summer/fall field seasons. Therefore, the agency is providing a temporary limit on the take prohibitions to allow such activities to continue until March 7, 2001 so that the necessary paperwork can be processed. However, to qualify for this "temporary" limit, researchers must submit a section 10 permit application to the Assistant Administrator for Fisheries (AA), NOAA by October 10, 2000 for research activities affecting listed fish in any of the 14 salmon or steelhead ESUs identified in this rule. Applicants would be subject to take prohibitions only after their permit application is denied, rejected as insufficient, or the "temporary" limit period expires, whichever occurs earliest. Researchers failing to submit an application by October 10, 2000 would be subject to take prohibitions beginning on September 8, 2000 for the seven steelhead ESUs and on January 8, 2001 for the seven salmon ESUs. NMFS will make every effort to respond to applicants in a timely fashion. However, researchers are advised to prepare for unavoidable delays that may result from the anticipated load of section 10 permit applications that will be presented to NMFS.

Parties requesting coverage under the ESA 4(d) limit on scientific research activities should consult with the ODFW, the California Department of Fish and Game (CDFG), the Idaho Department of Fish and Game (IDFG), or the Washington Department of Fish and Wildlife (WDFW) to determine when related applications are due to these oversight/coordination agencies. By October 10, 2000, NMFS will expect these agencies to submit a letter of intent to the AA, NOAA, summarizing the types of research to be covered under the 4(d) limit for any of the 14 salmon or steelhead ESUs identified in this rule. This letter will serve as a placeholder for these agencies (and the entities identified in their letter) until they can submit to NMFS a more comprehensive assessment of scientific research activities planned for the 2001 research season. Take prohibitions for these applicants would become effective after their application for the 4(d) limit is either rejected by NMFS or the "temporary" limit period expires, whichever occurs earliest. Applicants failing to submit a letter of intent by October 10, 2000 would be subject to take prohibitions beginning on

September 8, 2000 for the seven steelhead ESUs and on January 8, 2001 for the seven salmon ESUs. NMFS will work closely with the affected state agencies and researchers to select suitable reporting time frames and minimize the disruption of research efforts.

Comment 109: Several commenters requested that NMFS expand the ESA 4(d) limit on scientific research activities to include research by tribal fisheries biologists. Others requested that NMFS include a regulatory obligation for the states and NMFS to include tribes in reviewing scientific research and monitoring efforts subject to the ESA 4(d) limit.

Response: NMFS has provided a separate 4(d) rule for Tribal Plans (including research and monitoring activities) (published elsewhere in this **Federal Register** issue) the purpose of which is to establish a process that will meet the conservation needs of listed species while respecting tribal rights, values, and needs. A tribe intending to conduct research-related actions that may take threatened salmonids could submit a Tribal Plan to NMFS for consideration under the 4(d) rules. In addition, tribes have the opportunity to have tribal research activities covered under the research limit for salmon and steelhead, so long as the activities are in accord with state reporting requirements specified in that limit.

NMFS does not believe it is necessary to include a regulatory obligation under 4(d) that requires states to include a tribal co-manager review and concurrence process for research/monitoring activities. There are ample opportunities—both formal and informal—for Federal, state, and tribal co-managers to coordinate salmonid research and monitoring efforts and NMFS will continue to encourage such collaborative efforts. In addition, NMFS recognizes its responsibilities to confer with the tribes on ESA issues and will use this dialogue to ensure that tribal concerns are addressed. NMFS will make available to interested parties the documents describing the research and monitoring conducted under either the tribal 4(d) limit or the salmon/steelhead research limit.

Comment 110: Some commenters stated that the research limit was too narrowly defined and should be expanded to apply to other state and non-governmental entities (e.g., state water quality agencies, watershed councils, and sportsman groups). Others requested that NMFS clarify what is meant in the research limit by "oversight" and "coordinated."

Response: NMFS believes that the state fisheries agencies are in the best position to oversee and coordinate scientific research and monitoring efforts involving listed salmonids. While other entities (e.g., other state agencies, academics, consultants, etc.) have considerable expertise in fisheries research, none have the clear management responsibility for salmonids that is vested with the state fisheries agencies. Moreover, NMFS is concerned that expanding this limit to include numerous entities would hinder the coordination of research efforts. NMFS encourages coordination as a means to minimize research impacts on listed salmonids while facilitating data exchange and interpretation.

NMFS agrees that minor modifications to this limit's description will help clarify the agency's intent for "oversight" and "coordination." For example, with respect to "oversight," NMFS does not believe that a state fishery agency must directly supervise or inspect every research project. Instead, NMFS intended that research efforts covered by the ESA 4(d) limit should merely be identified and approved by the appropriate state fishery agency. The identification and approval processes should constitute nominal extensions of the pre-existing system for obtaining a state research/collection permit. In addition, NMFS' emphasis on "coordination" was to encourage the state fisheries agencies to establish and improve upon mechanisms for organizing research and monitoring of listed salmonids. Such coordination could occur at a state-wide level (e.g., the Oregon Plan for Salmon and Watersheds), at a level addressing a particular ESU (e.g., Washington's Hood Canal and Eastern Strait of Juan de Fuca Summer Chum Recovery Plan), or watershed. No matter what the level, however, the state fisheries agencies will still need to provide NMFS with the requisite annual reports. NMFS will continue to work with the affected states to better define the reporting requirements supporting this limit, maximize the information being gathered on fish and wildlife species (while minimizing impacts on threatened and endangered species), and ensure that sound research proceeds unencumbered by regulatory/permitting requirements.

Comment 111: Some requested that this limit be made available to Federal researchers and asked for clarification on the relationship between this limit and ESA section 10 permits.

Response: NMFS clarifies that Federal research and monitoring activities could be covered under the research limit. Federal lands encompass vast areas of salmonid habitat in the Pacific Northwest and California, and Federal research efforts contribute vital information about these species. Therefore, NMFS believes it is necessary and advisable to provide the opportunity for Federal researchers to receive coverage under the research limit. Such coverage would obviate the need for an ESA section 10 permit for these Federal researchers. Still, in deference to the need for close coordination with state and other efforts (plus the fact that Federal researchers will still need research and collection permits from the state fisheries agencies), Federal research will only be covered under the ESA 4(d) limit when that research is overseen by or coordinated with a state fisheries agency that is willing and able to report on the Federal research effort. Also, it is important to note that coverage under the research limit would not relieve Federal agencies of their duty under section 7 of the ESA to consult with NMFS if actions they fund, authorize, or carry out may affect listed species.

Comment 112: Some commenters contended that NMFS was placing unnecessary constraints on electrofishing as a sampling technique. Several requested clarifications and revisions to specific protocols described in NMFS' "Guidelines for Electrofishing Waters Containing Salmonids Listed Under the Endangered Species Act" (NMFS, 2000a), in particular they sought revisions in the guidelines pertaining to numeric standards/settings and documenting crew experience and sampling history. One commenter requested that NMFS expand the limit and guidelines to address electrofishing from boats.

Response: NMFS contends that the guidelines are both reasonable and necessary for the conservation of listed salmon and steelhead ESUs. The literature is replete with evidence to support NMFS' concerns that electrofishing can be particularly harmful to salmonids and other fishes (see review by Nielsen, 1998). Before distributing the existing guidelines in 1998, NMFS held a workshop and distributed the subsequent guidelines for peer review. The resulting guidelines reflect reasonable and prudent measures for minimizing the adverse effects of electrofishing. NMFS will continue to encourage researchers to use other less invasive techniques (e.g., traps and snorkeling surveys), but recognizes that electrofishing has utility, or is the only practical alternative in certain study designs.

With respect to specific concerns about the electrofishing guidelines, NMFS disagrees with most of the issues raised and believes that only minor modifications are warranted in these protocols. For example, the agency disagrees with several commenters that requiring conductivity measurements would impose an onerous and costly burden on researchers. It is well known that water conductivity is one of the most critical parameters determining electrofishing impacts and conductivity meters are both inexpensive and readily available. The concerns that NMFS is requiring too much documentation (e.g., logging crew experience and data on sampling results) are also unsound. Most, if not all, researchers record the time spent (e.g., time counters are an integral part of most backpack units) and results of electrofishing surveys (e.g., numbers of fish encountered, injuries observed, site conditions, etc.). These logs aid fish by helping to improve the researcher's technique and can form the basis for training new operators.

With respect to boat electrofishing, NMFS has serious concerns with this technique because it has even greater potential for seriously injuring listed salmonids. For example, the technique can employ electrical output that is an order of magnitude greater than backpack electrofishing units, and environmental conditions can seriously limit a researcher's ability to minimize impacts on listed fish (e.g., adult salmonids in large and turbid stream reaches). NMFS has not developed suitable guidelines for this sampling technique and will continue to request that researchers desiring to employ electrofisher boats apply to NMFS via the ESA section 10 permit process.

Comment 113: Some commenters requested that NMFS clarify which entities would be covered under the limit for rescue and salvage actions and better define what constitutes an "emergency" under this limit. One commenter requested that NMFS specifically allow electrofishing under the rescue/salvage limit.

Response: The regulations pertaining to this limit state that rescue/salvage can be conducted by "any employee or designee of NMFS, FWS, any Federal land management agency, IDFG, WDFW, ODFW, CDFG, or any Tribe." A designee of the listed entities is any individual that the Federal or state fishery agency, or other co-manager has authorized in writing to perform the rescue/salvage.

While it is not possible to characterize all scenarios constituting an "emergency" for listed salmonids, fish strandings resulting from natural or human-induced events are probably the most common type encountered. For example, an emergency condition may exist as a result of dewatering (e.g., for irrigation), damming, drought conditions, or when listed fish become stranded in channels or ponds following a flood event, landslide, or debris torrent. Chemical spills associated with industrial effluents or vehicular accidents (e.g., train or automobile accidents) have also been known to create an emergency for salmon and steelhead. These are just a few examples of scenarios that the employees or designees might face. Obviously professional judgement will need to be applied at the scene of an emergency to determine if and how listed fish should be rescued.

NMFS concurs that electrofishing is permissible when there is no better technique for safely removing stranded fish under the rescue/salvage limit. However, the electrofishing should be conducted in accordance with NMFS' backpack electrofishing guidelines.

Fishery, Hatchery, and Genetic Management Activities

Comment 114: Some commenters stated that the proposed ESA 4(d) rules potentially grant broad exemptions for taking listed species in hatchery programs and fisheries and that these limitations should be omitted or tightened to better control hatchery and harvest practices.

Response: The final rules establish explicit criteria and standards that hatcheries and harvest activities must adhere to in order for them to be eligible for limitations on section 9 take prohibitions. The criteria include detailed plans, risk assessments, and monitoring and evaluation and are similar to what has been required for section 10 permits in the past. The Fishery Management Evaluation Plans (FMEPs) and Hatchery Genetic Management Plans (HGMPs) will be evaluated using the same standards used to examine section 10 permit applications. The limits for hatcheries and harvest will not decrease the level of protection for listed species.

Comment 115: There was general support for the concepts detailed in the technical document "Viable Salmonid Populations." However, there was much concern over how to apply these concepts in actuality. A number of commenters stated that in most cases there would not be enough information to determine population structure and abundance thresholds. Many commenters thought VSP should be implemented through NMFS' recovery planning efforts.

Response: NMFS realizes that a substantial amount of information needs to be generated in order for FMEPs and HGMPs to be consistent with the "Viable Salmon Populations" technical document. Ideally, that information would arise out of the technical phase of the recovery planning process. However, even if all the data are not yet available, the concepts contained in VSP are valid and will still be used to help develop and evaluate FMEPs and HGMPs. Determining "critical" and "viable" thresholds in the management plans allows actions to be tied to the status of listed fish in a particular population or management unit. If a population or management unit is at critical levels, actions must be strictly controlled and not impede recovery. At viable levels, the population or management unit is healthy and more flexibility exists for fisheries and hatchery management. NMFS will work with the co-managers to apply VSP to the greatest extent possible for any given management unit. As additional monitoring and evaluation are completed in the future and as recovery plans are developed, the FMEPs and HGMPs will be revised.

Comment 116: Some commenters suggested that no progeny of listed fish that were spawned in a hatchery should be considered listed under the ESA.

Response: Listed fish may be taken into a hatchery for spawning as a last resort to conserve the species. Before this can occur, an approved HGMP or ESA section 10 permit must be obtained. The HGMP or section 10 permit specifies the number of listed fish that can be taken into the hatchery. The status of the (artificially propagated) progeny of these fish is determined at the time the species is listed (i.e., stated in the final listing determination). If the hatchery program is part of an ESU where the progeny of listed fish spawned in a hatchery are considered to be listed, NMFS may proceed through rulemaking to delist hatchery progeny once an HGMP or section 10 permit is in place.

Comment 117: Some commenters questioned the strategy of restricting steelhead fisheries to areas where only hatchery-marked steelhead are expected to occur and prohibiting the retention of listed steelhead. It was asserted that this policy could be a disincentive for local recovery efforts because healthy, naturally reproducing populations of fish could not be utilized if the population recovers.

Response: NMFS agrees that recreational fisheries should not be limited to streams where only hatchery fish are present. NMFS intends to manage fisheries based upon a listed ESU's status and a given fisheries' impacts on that status. The ultimate goal is to recover and maintain natural, self-sustaining ESUs so that ESA protections are no longer necessary. Under the VSP concept, if a steelhead population has recovered to viable abundance levels, more harvest impacts could be allowed than would be advisable for an adjacent population whose status is poor.

Comment 118: Several commenters requested clarification on the meaning and purpose of sanctuary areas, and some questioned the rationale for not requiring the designation of sanctuary areas in FMEPs under the salmon ESA 4(d) rule, but requiring them in FMEPs under the steelhead 4(d) rule. (Note: the proposed 4(d) rule for salmon (65 FR 170, January 3, 2000) was published separately from the proposed rule for steelhead (64 FR 73479, December 30, 1999). The two proposed rules have been combined in this final rule.)

Response: NMFS defines sanctuary areas in the FMEPs as areas that are closed to fishing. NMFS' intent is to provide areas where juvenile and adult fish are not exposed to any fishing-related pressure or mortality (including catch and release fisheries, which can have an associated incidental mortality). Tributary streams or stream reaches that are the primary, core areas where listed fish spawn and rear in a given watershed would be good areas to designate as sanctuaries.

Establishing sanctuary areas is especially important for species (like steelhead) that can spend several years rearing in fresh water and may be exposed to multiple fishing seasons. Juvenile salmon are generally less vulnerable to fishing because they typically emigrate to the ocean by the time they are one year old. However, some juvenile salmon (e.g., sockeye) can also exhibit extended freshwater residence. NMFS agrees that sanctuaries should also be included in the FMEPs developed for the listed salmon ESUs. The extent of the existing (and future) sanctuary areas for juvenile and adult fish will be evaluated on an ESU-by-ESU basis when the FMEPs are reviewed.

Comment 119: One commenter contended that sanctuaries may be difficult to establish in many California river systems (e.g., Central Valley streams) and asked how many sanctuaries would be needed to get NMFS' approval of an FMEP.

Response: NMFS agrees that it may be difficult to designate sanctuaries in the Central Valley system given that the majority of historical habitat is now inaccessible to fish. However, there are other accessible river systems inhabited by the three steelhead ESUs covered by this ESA 4(d) rule that currently do not offer sanctuary protection in critical spawning and rearing habitats. The FMEP process will allow NMFS to work with co-managers in establishing angling sanctuaries in these areas to further protect and conserve steelhead while still allowing appropriate angling opportunities to proceed. The appropriate numbers of sanctuaries will arise out of the FMEP development process.

Comment 120: Some commenters questioned whether the FMEP process is necessary for sport angling and contended that developing elaborate FMEPs is not the best use of limited technical and restoration resources.

Response: The FMEP process will make it easier to work with the co-managers in making sure that sport fishing activities comply with the intent of this limit. While the amount of information that NMFS requires for FMEP approval will be similar to information required for an ESA section 10 incidental take permit, the FMEP route provides a longer-term framework for fisheries management and is thus more efficient over time in addressing recreational fishing impacts on listed species.

Comment 121: Some commenters requested that recreational fisheries in California receive a limit on the take prohibitions because they are likely to have only minor impacts on listed species.

Response: NMFS recognizes that CDFG has instituted conservative fishing regulations in many of the steelhead-bearing streams found in California. These regulations allow for continued angling opportunities, where appropriate, while providing some level of protection for listed steelhead through gear, season, and area restrictions. Although take associated with modern recreational fisheries has not been identified as a major reason for the depressed status of many California steelhead ESUs (NMFS, 1996), there is still a general lack of monitoring from which to derive reliable quantitative estimates of impacts in selected steelhead streams (e.g., Antelope, Deer, and Mill Creeks in the Central Valley steelhead ESU). In addition, take provisions and angling regulations may need to be more restrictive in areas where habitat conditions are not properly functioning and angling pressure would exacerbate the risks faced by a listed population. An approved FMEP would provide the means to identify these monitoring gaps and open the way for agreements with co-managers on instituting appropriate measures and securing funding sources.

Comment 122: NMFS should not require FMEP monitoring that is physically or fiscally impractical.

Response: NMFS agrees with this comment and will make every effort to work cooperatively with co-managers to identify resource monitoring and assessment requirements on an ESU-by-ESU basis. The required level of monitoring will be tied to a population's status and the degree to which a specific fishery poses risks to that population. There is sufficient flexibility in the ESA 4(d) rule to accommodate the immediate staffing and funding shortfalls. One of the integral parts of the FMEP process, however, will be to identify the level of monitoring and assessment needed to adequately address the impacts of recreational angling on listed species in a given ESU. Strategies for prioritizing monitoring needs based on funding and staffing capabilities will be stipulated in letter of concurrence NMFS crafts in response to an approved FMEP.

Comment 123: Several comments addressed the use of barbed hooks in recreational fisheries for trout and steelhead. One commenter questioned the scientific basis for disallowing barbed hooks in adult steelhead fisheries. Other commenters believed that catch and release mortality could be significantly reduced by requiring the use of barbless hooks.

Response: The available scientific data have not shown that using barbless hooks consistently or significantly reduces catch and release mortality in trout and steelhead fisheries, and the ESA 4(d) rule does not require barbless hooks in recreational fisheries. However, NMFS believes certain fishery situations could warrant the use of barbless hooks to minimize potential impacts on listed fish.

Comment 124: Several commenters were concerned with language in the ESA 4(d) rules relating to restrictions on resident species fisheries. Some contended that restrictions should be placed on any fishery (resident or anadromous species) that substantially affects listed fish. Others believed the restrictions to be excessive and stated that NMFS should more fully assess the impacts of resident species fisheries on listed salmon and steelhead.

Response: All fisheries that potentially affect listed salmon and steelhead must be evaluated in the appropriate FMEP. NMFS' intent is to point out the fact that some resident species fisheries can affect listed fish. In these circumstances, the FMEP must include angling regulations for resident species fisheries that minimize any take of listed species. An FMEP may also include restrictions on anadromous fisheries to ensure that listed species are conserved.

Comment 125: One commenter stated the need to clarify certain definitions used in relation to the hatchery programs. It was asserted that several hatchery programs still have definitions of "natural" fish that seriously obscure the differences between wild and hatchery-produced fish. The commenter stated that the HGMPs should address this problem.

Response: NMFS agrees with this comment. Therefore, to clarify, NMFS generally uses the terms "natural" and "hatchery" to describe the origin of anadromous fish following the definitions found in Bjornn and Steward (1990): hatchery fish are those that, regardless of parent stock, have been spawned, incubated, hatched or reared in a hatchery or other artificial production facility. Naturally produced fish are those that result from natural spawning in streams. As Waples (1991) stated, the terms wild and natural are used synonymously to refer to naturally produced fish without regard to the origin of the parent stock.

Comment 126: The HGMP and FMEP templates should be referenced in the 4(d) rules.

Response: This suggestion has merit and language in this final rule has been duly altered. The templates are available on NMFS' Northwest Region website (www.nwr.noaa.gov).

Comments related to the criteria established for FMEPs and HGMPs

Comment 127: Some commenters questioned the assertion in the harvest limit that at critical threshold levels, harvest actions must not appreciably increase the genetic and demographic risks facing the population. They stated that this policy does not ensure the conservation of listed species and that any populations that are at critical threshold levels should not be put at risk. They asserted that harvest should be very restricted or totally eliminated when a population reaches critical levels.

Response: When a population within a listed ESU is at critical levels, impacts from fisheries must be strictly controlled. No fishery will be allowed under the ESA which jeopardizes the continued existence of an ESU. In some cases it may be necessary to close or curtail fisheries to protect listed fish. The intent of this language was to realize that incidental harvest may occur even under a tightly regulated fishery regime. Anadromous salmonids have a vast migratory distribution and may be incidentally intercepted in fisheries occurring in other regions. NMFS will evaluate FMEPs to ensure that the harvest regime will protect individual populations and allow the ESU to recover before being approved.

Population-level assessments under the ESA are meant to provide information on abundance, productivity, structure and diversity specific to each population, and are essential to determining an ESU's overall health. However, under some circumstances the ESU as a whole may be viable even though some individual populations have not fully recovered. NMFS and the TRTs appointed to help develop de-listing criteria will determine which, where, and to what degree populations within an ESU must have "viable salmonid population" status to render adequate ESA protection at the ESU level.

Comment 128: One commenter stated that no transgenic or genetically engineered fish should be allowed in waters where listed fish reside.

Response: No action that jeopardizes the continued existence of listed species is permitted under the proposed 4(d) rules or any other section of the ESA. If NMFS assumes that "transgenic or genetically engineered fish" are not native species and determines that their introduction into waters where listed fish reside would not help recover listed species, these fish would likely be prohibited.

Comment 129: Some commenters believed that the final rules should contain citations that demonstrate the validity (including associated risks) of supplementation as a tool for recovery. Some organizations are doubtful that supplementation is effective.

Response: There is considerable scientific uncertainty regarding the extent to which benefit can be derived from supplementing naturally spawning populations with hatchery-produced fish. There are well-publicized examples of domesticated, hatchery-produced salmon and steelhead having negative effects on natural production (Kalama River-Skamania summer steelhead). There are also examples where artificial propagation of the local, indigenous, stock appears to have increased or sustained the number of naturally spawning fish (Imnaha and South Fork Salmon River summer chinook, Upper Columbia steelhead, Rogue River coho). The proposed HGMPs require programs to be designed using the best current scientific knowledge in order to identify and manage risks and provide benefits to the listed species. The HGMPs are required to identify goals, adopt performance standards, and conduct comprehensive monitoring and evaluation in order to help evaluate supplementation success and resolve any uncertainties about the practice.

Comment 130: Some commenters stated that artificial propagation has failed to maintain wild fish populations and all hatchery programs should be discontinued.

Response: Few of the original artificial propagation programs were designed to maintain wild populations. By developing and implementing HGMPs under the ESA, these programs will address wild population conservation and recovery. The risks and negative effects associated with artificial propagation programs are being identified and managed. It is true that artificial propagation has not been able to maintain wild anadromous fish when dam building, habitat loss, and fishing has continued at the established pace. Reforming hatchery practices is advisable, but discontinuing all artificial propagation is not necessary to restore natural fish under all circumstances. In many cases, hatchery programs are managed to minimize risks to wild populations while providing other benefits, such as supplying harvestable numbers of fish to meet treaty trust responsibilities.

Comment 131: One commenter stated that NMFS should not use HGMPs to police compliance with court orders.

Response: NMFS cannot approve an HGMP that does not comply with legal mandates established by statute or court order. This criterion is intended to remind the applicants that an HGMP must be legally as well as biologically complete.

Comment 132: Several comments addressed the experimental nature of supplementation programs and the need for hatchery program goals to protect genetic diversity and individual wild fish stocks. Furthermore, specific concerns were raised about the need to ensure that monitoring and evaluation activities adequately protect listed fish.

Response: NMFS agrees with the general thrust of these comments. Supplementation programs are viewed as being experimental; they can vary from program to program depending on the purpose of the program, the species targeted, stock status, and location. Because of supplementation's experimental nature, HGMPs assume an adaptive management approach for such programs by requiring extensive monitoring and evaluation. These activities must be able to identify deleterious effects on listed fish so the program can be modified. Furthermore, HGMPs are designed to protect genetic diversity in wild populations (both listed and non-listed) by improving hatchery management, monitoring, and evaluation.

Comment 133: Some commenters questioned how mining wild fish populations for broodstock contributes to recovery when a population is at or below the critical threshold.

Response: When populations reach critical levels and the best available scientific information indicates that the demographic risks are greater than the genetic risks, using artificial propagation to prevent imminent extinction may be the least risky alternative. When populations are at or below the critical level, the only hatchery programs NMFS is likely to approve would be for the sole objective of enhancing the listed species' propagation and survival. If the cause of the decline is short-term, then the hatchery program could be reduced once the population exceeds the critical threshold. If the cause for the decline cannot be remedied in the short-term, the hatchery can act as a genetic broodstock bank and maintain the population until the causes for decline can be addressed.

Comment 134: Some commenters had concerns about NMFS' decision making process in determining whether an HGMP adequately avoids or minimizes any deleterious effects. They desired to know how the standards for this determination would be set and sought an exact description of the monitoring program.

Response: NMFS has developed a detailed HGMP template in collaboration with scientists from the other state and Federal agencies and treaty Indian tribes. The template is available on the NMFS Northwest Region's website at www.nwr.nmfs.gov. The template references many documents that provide guidance on artificial propagation in terms of setting performance objectives, identifying, evaluating, and managing risks, and monitoring results. NMFS' fishery scientists will review the HGMPs for completeness and adequacy. The HGMPs are also being used in sub-basin planning and in the Northwest Power Planning Council (NPPC) funding process where they may be subject to review by fishery scientists employed by Council staff as well as one or more layers of independent scientific review. The HGMPs will be available for public comment and peer review before they are approved. NMFS believes this process will help ensure deleterious effects are being adequately managed. However, all hatchery programs pose some degree of unavoidable risk to natural populations.

Comment 135: One commenter suggested that hatcheries should produce as many fish as possible and held that there is no scientific basis for favoring natural fish over hatchery fish.

Response: NMFS strongly disagrees. Hatchery fish have been identified as one of the factors causing population declines in a number of ESUs. There is a substantial body of scientific evidence to show that hatchery fish can harm natural fish by preying on them, competing with them for food, shelter and mates, displacing them from their native habitats, and creating other effects.

Comment 136: One commenter stated that NMFS failed to address the issue of hatchery structures that can block fish passage.

Response: Each HGMP will include a section describing the hatchery facilities. It will identify passage issues and water withdrawals and screening facilities. If passage is an issue, it can be addressed through HGMP implementation. Passage is also evaluated in ESA section 10 permits for hatcheries.

Comment 137: One commenter recommended that hatchery fish be protected in the 4(d) rules, not just wild fish.

Response: The ESA emphasizes the restoration of listed species in their natural habitats. However, section 3(3) of the ESA specifically recognizes the potential for artificial propagation to help achieve rebuilding objectives. Specific protections for hatchery and natural fish reared in a hatchery are detailed in the HGMPs, especially if the hatchery program is used to supplement natural populations. In certain cases, NMFS has determined hatchery fish stocks to be essential to recovering the ESU and has listed them under the ESA.

Comment 138: One commenter questioned how NMFS will determine whether a catch and release fishery is allowable.

Response: Any selective fishery proposal, including those requiring that listed fish be released after being caught, will be evaluated based on its impacts on listed ESUs. The sum total of all fishery-related impacts on a listed ESU will be considered in terms of its effects on population viability and, when applicable, within the structure of any existing HCP or recovery plan. No fishery that jeopardizes an ESU's continued existence or poses risk to key populations in that ESU will be allowed.

Specific Comments Related to FMEPs

Comment 139: Several commenters desired to know how fishery mortality would be allocated and asked what the mechanism would be for treating ocean, mainstem river, and tributary harvest consistently. They asserted that all fishery related mortality should be accounted for.

Response: Once take prohibitions are in effect, any fishery with the potential to impact listed fish is subject to NMFS' ESA review and approval process. All agencies proposing fisheries that have a potential to affect listed stocks are required to quantify these impacts. These agencies are required to comply with ESA review requirements and obtain take authorization through a 4(d) rule limit, a section 7 consultation, or section 10 permit application. Compliance is determined by tallying all fishery related incidental take from all agencies. Rigorous monitoring and evaluation programs ensure that impacts remain within acceptable limits.

The FMEPs will specify adult escapement targets and harvest rates for each ESU. The purpose of the ESA 4(d) rules is to accommodate the listed species' biological needs, not to allocate harvestable surplus. That is a co-manager responsibility and is undertaken in a number of different venues.

Comment 140: Numerous comments related to specific information and requirements included in actual FMEPs. The comments mainly addressed specific gear and season restrictions and the need to regularly review the FMEPs to ensure that they protect listed species.

Response: The FMEPs will be evaluated under the same standard used for ESA section 10 permits: the proposed action(s) must not jeopardize the continued existence of the listed ESU. The FMEPs will specify the maximum exploitation rates—depending on listed fish abundance—or will specify escapement levels. Each FMEP will include the time frames for regularly reviewing it. Depending on the fishery's location and circumstance, specific angling regulations may be detailed in the FMEP (e.g., minimum length and bag limits for trout fisheries). In other cases (e.g., some salmon fisheries), the specific regulations may be adopted once the exploitation rate or catch quota is determined by examining pre-season run forecasts.

Comment 141: Some commenters stated that maximum escapement objectives and reasonable exploitation rates should be specified in the FMEPs.

Response: NMFS strongly agrees that escapement objectives must be determined for each fish stock and those objectives must be the fundamental drivers of fishery harvest management. Parties to *U.S.* v *Washington* and *U.S.* v *Oregon* should develop—through regional management plans and based on biological requirements and fishery needs—escapement objectives and exploitation rate targets for each stock or management unit.

Comment 142: Several commenters suggested that all hatchery chinook should be marked and that selective fisheries should be required.

Response: From an ESA perspective, several obvious and significant benefits derive from applying a visual mark to hatchery chinook—most notably the ability to easily monitor hatchery stray rates and differentiate hatchery fish from natural fish for stock assessment purposes. In addition, marking all hatchery fish can help managers evaluate productivity among hatchery and wild fish—an important piece of data for recovery planning. Because it now can be accomplished with machines on a massive scale and with relatively little impact on survival, the adipose fin clip achieves these benefits in a very cost-effective and efficient manner.

By enabling selectivity, mass marking may also provide the means for sustainable fisheries—clearly a very important objective. However, because a number of critical issues related to ongoing coded wire tag (CWT) programs remain unresolved, NMFS shares the view of its co-managers that decisions made now to mass mark hatchery chinook are separate from decisions to be made later regarding selective fisheries. Even in cases where NMFS has required that a hatchery production run be mass-marked because of ESA concerns, this does not imply that a selective fishery will subsequently be endorsed. It is not NMFS' policy to require that all hatchery production be mass marked. Rather, our policy is that mass marking must be decided on a case-by-case basis after taking into account, among other things, the specific objectives of the hatchery production, the intended purposes of the mark, and the effect the hatchery production would have on fish listed under the ESA.

Comment 143: One commenter asserted that any rulemaking must ensure that treaties will be respected and that harvestable numbers of fish result.

Response: NMFS agrees. As several court cases have found, conserving and recovering listed stocks under the ESA to the point where they no longer need the protections of the ESA is entirely consistent with the long-term objective of having healthy harvestable populations and the exercise of treaty rights to fish and hunt. From a larger perspective, the greatest improvements in tribal fishing opportunity will not accrue over the short term but through the long-term recovery of the populations. Federal trust responsibility is best fulfilled at this time by engaging in conservative fisheries management. At the same time, hatchery production can be used to provide harvestable fish if such programs can be shown to be consistent with recovering wild fish.

Comments Related to the Time Frame for Developing and Commenting on FMEPs and HGMPs

Comment 144: Numerous agencies, organizations, and individuals commented that enough time must be allowed to develop and review the FMEPs and HGMPs. Several commenters suggested providing a grace period from several months to several years after the final rules are published for developing and approving FMEPs and HGMPs.

Response: NMFS realizes the significant amount of work and time required to develop and process FMEPs and HGMPs. Therefore, NMFS is providing 6 months until take prohibitions go into effect for the listed steelhead ESUs to allow additional time to develop and approve FMEPs and HGMPs.

In addition, NMFS has also provided a transition period of 6 months for recreational fisheries that affect listed steelhead. NMFS has assessed the angling regulations currently in effect for juvenile and adult steelhead in California, Oregon, Washington, and Idaho and has concluded that listed steelhead will be sufficiently protected during this 6-month period. This will allow additional time to develop and approve FMEPs for the steelhead ESUs. Some fisheries and hatchery programs will not need ESA coverage immediately after take prohibitions go into effect because the actions do not affect listed species. NMFS will work with the co-managers to prioritize fisheries and hatchery programs on the basis of how urgently each needs ESA coverage.

Comments Related to the Process of Reviewing/approving/implementing FMEPs and HGMPs

Comment 145: Some commenters suggested that NMFS include a provision for independent scientific review of the FMEPs and memorandum of agreement (MOAs) between NMFS and the action agency.

Response: As stated in the rules, the public will have the opportunity to review and comment on FMEPs and HGMPs for at least 30 days before NMFS acts on them. During this comment period, independent scientific entities are invited to review and comment on FMEPs and HGMPs. NMFS intends to address the public comments with the appropriate co-manager before approving any plan.

Comment 146: Some commenters wanted NMFS to define the "regular basis" on which limits will be evaluated. They also wanted to know what the time frames for reporting would be.

Response: NMFS and the individual co-manager will decide on a case-by-case basis the review and evaluation requirements for an approved FMEP or HGMP. The FMEPs and HGMPs will specify the time frames for regularly reviewing the plans and that information will be included in NMFS' letter of concurrence on the management plans. Depending on the circumstances, management plans may be evaluated every year or after analyses are complete. This will reasonably accommodate the time needed to prepare post-season catch and effort reports as well as any analyses the co-managers need for adjusting fishing regulations. However, whenever practical, the evaluation and review process should embrace an annual time frame so that appropriate adjustments may be made before the next fishing season.

Comment 147: Some commenters were concerned that a final HGMP was not available at the time of the proposed rules and that the final criteria for HGMPs may be substantially different from those cited in the proposed ESA 4(d) rules.

Response: The final draft of the HGMP template has been available to co-managers and posted on NMFS' web site since January of 2000. This template includes the information that must be included in the HGMPs for approval. Based on the public comments received, the criteria and the template for HGMPs have not changed substantially in the final rule.

Comment 148: A few commenters stated that the process for approving a hatchery broodstock program should be clearly described.

Response: NMFS believes the process is clearly described in the proposed and final rules. A state or Federal co-manager who wishes to utilize the ESA 4(d) process rather than the section 10 process must develop a detailed HGMP.

The HGMP must address the criteria in the 4(d) rule and follow the template NMFS has provided. The draft HGMP will be made available for public comment for at least 30 days. If NMFS determines the HGMP adequately addresses the established criteria, we will issue a written concurrence or, in the case of a Federal action, we will conduct a section 7 consultation. NMFS believes this process allows the public an adequate amount of time to review and evaluate a hatchery broodstock program before it is approved.

Comment 149: One commenter pointed out that the assumption that average hooking mortality is less than 5 percent is based on only one study (Hooton,1987). Based on the scientific literature, they felt this rate to be low and recommended that NMFS further evaluate hook and release mortality rates in the literature.

Response: NMFS agrees that hooking mortality deserves further investigation and we are committed to doing so. However, for now the 5 percent rate reported in Hooton (1987) seems to constitute a reasonable average. Other studies do show higher mortality rates for salmonids when stream temperatures are elevated (Klein, 1965; Dotson, 1982; Titus and Vanicek, Taylor and Barnharnt, 1997), but for most conditions, Hooton's estimates are reasonably accurate.

Habitat Restoration Activities

Comment 150: One commenter stated that NMFS itself should develop the WCP guidelines.

Response: NMFS believes that the states are in the best position to perform the lead role in developing these guidelines. The geographic scope of this rule covers four states, an area over which biological and geological factors vary considerably. Even more importantly, each state's agencies, regulations, and conservation programs are unique and the WCP guidelines, to be effective, should be designed to fit within that unique context. The states' natural resource agencies have relatively large and expert staffs that are better prepared to interact with the entities that will use these guidelines. For these reasons, this limit remains founded upon the development of state WCP guidelines.

Comment 151: Numerous commenters stated that the interim provisions of § 223.203(b)(8)(ii) (in the proposed rule, 65 FR 170, January 3, 2000) should be extended beyond 2 years, or were too permissive, or too restrictive. Many of these commenters proposed inclusion of specific activities that were not included in the six proposed interim provisions.

Response: NMFS observes that the interim provisions of § 223.203(b)(8)(ii) have been misunderstood to such an extent that NMFS has dropped these provisions from the final rule. The intent of these proposed interim provisions was to acknowledge that getting WCP guidelines and plans in place will require time, and the potential benefit to listed salmonids of allowing certain relatively low risk habitat restoration projects to proceed in the near term might outweigh the risk entailed by those activities not being part of a WCP.

However, the interim provisions had been widely misperceived as detailed regulation of habitat restoration activities. NMFS did not intend to provide for the direct regulation of habitat restoration activities under the terms of this rule and regrets that the earlier proposal created this false impression. Accordingly, NMFS now deems it advisable to simply drop the interim provisions from this final rule. Many low risk activities (e.g., riparian exclosure fencing or native vegetation planting), simply do not carry an appreciable risk of taking. Activities involving instream construction or modification of the streambed or banks require CWA section 404 permits which carry ESA section 7 coverage. All habitat restoration activities will entail less risk and more benefit if they are part of an approved WCP, and NMFS encourages the timely development of WCP guidelines and plans. Habitat restoration projects are less likely to be successful if undertaken without supporting analyses that disclose habitat impairments and absent resource management adjustments within the watershed to redress the underlying causes of those impairments.

NMFS strongly encourages jurisdictions, entities, and citizens to use the habitat restoration guidelines and technical manuals referenced in "A Citizen's Guide to the 4(d) Rule" (NMFS, 2000) as readily available techniques to reduce the risks of harm or injury to the listed stocks. In the event that an allegation arose about a potential ESA section 9 violation, NMFS would furthermore take into account the efforts of the watershed group or entity to adhere to the relevant guidelines. Where injury or harm was resulting in such a circumstance, NMFS believes that the proper and most effective remedy would be an orderly adjustment in the relevant guidelines and not the prosecution of a section 9 violation against an individual project.

Comment 152: Several commenters had questions regarding what entities are responsible for developing and implementing WCPs and what state agency is responsible for certifying the plans.

Response: This final rule intentionally leaves these questions unanswered. There are potentially many different entities that may be responsible for developing WCPs in different circumstances—watershed councils, soil and water conservation districts, city or county governments, regional authorities, and so forth. NMFS finds it unnecessary to limit by rule what types of entities may produce and carry out WCPs. Likewise, NMFS leaves it to the individual states to determine the appropriate agencies for developing guidelines and certifying plans.

Comment 153: Many commenters had concerns about the clarity and intent of the approval criteria for the WCP guidelines.

Response: The criteria have been modified in this final rule to make them clearer and more effective.

Comment 154: Some commenters suggested that Federal activities—particularly habitat restoration activities—should receive a limit on the take prohibitions. CDFG suggested that restoration activities conducted under the Department's Fishery Habitat Restoration Program are already covered by their incidental take permit associated with their Corps of Engineer (COE) 404 permit consultation.

Response: Federal agencies that engage in, permit, or fund activities that may affect listed species are required under section 7 of the ESA to consult with NMFS. The ESA contains no provision to exempt Federal actions that involve habitat restoration activities from their section 7 obligations. Habitat restoration activities would only need to seek approval under this limit if they have more than a negligible likelihood of taking listed salmonids, and are not covered by any section 10 permit or section 7 incidental take statement.

Comment 155: Several commenters were concerned that neither the states nor NMFS will have the necessary resources to handle such a large number of written approvals; also, some stated that it was inappropriate for a state or NMFS to review individual projects after having approved an overall plan.

Response: NMFS agrees that the workload associated with approving all individual restoration projects and activities could overwhelm state and NMFS staff resources. In addition, activity-level review could defeat much of the process efficiency gained in the WCP approach. This final rule has been changed to require only state certification of WCPs, and NMFS' approval of the state guidelines (with a periodic review of the state certification process to ensure that WCPs are adequately analyzed). Provisions for clearly identifying whether particular activities are part of an approved plan must be part of the plans themselves and need not necessarily involve state or NMFS staff directly.

Comment 156: One commenter asserted that it is unclear which criteria NMFS will use in concurring with a state certification of a WCP.

Response: NMFS has amended the final version of this rule to drop the requirement of NMFS concurrence with the certification of individual WCPs. NMFS expects the criteria for the relevant state certifications will be contained in the state restoration guidelines anticipated by this final rule, and will periodically review the states' certification process for appropriate rigor.

Comment 157: One commenter proposed a stepwise approach toward making the transition from the specified activities of § 223.203(b)(8)(ii) interim period to allow development of state guidelines and WCP to the WCP context of § 223.203(b)(8)(i).

Response: NMFS agrees with the commenter, and in response the interim provisions proposed as 223.203(b)(8)(ii) have been deleted from the rule.

Comment 158: One commenter suggested integrating FMEPs and WCPs. Another stated that WCPs should be a part of the recovery planning process and not be evaluated piecemeal.

Response: In essence, the first commenter is suggesting recovery plans, which NMFS agrees are necessary for the conservation of the species and intends to develop for listed salmon. However, NMFS does not believe that completed recovery plans are a necessary prerequisite for all habitat restoration activities. While the existence of an overarching recovery plan could make constituent watershed conservation planning both easier and more effective, it does not follow that adequate watershed conservation planning cannot be done prior to the existence of a recovery plan.

Comment 159: Numerous commenters suggested that local governments should be recognized and allowed to develop guidelines and WCPs without state or Federal approval or the 2-year time line. A few commenters further questioned the scope and scale of the plans or pointed out the burden the process would place on local governments.

Response: The 2-year interim period has been deleted from this final rule, so the time line for developing guidelines and WCPs is now entirely up to the states and the entities desiring to perform habitat restoration activities. NMFS recognizes and appreciates the efforts local authorities are putting forth in watershed planning and habitat restoration projects. Nevertheless, NMFS is not prepared to individually review and approve WCPs, and has dropped that requirement from the final rule. State technical guidance can certainly assist localities in watershed conservation planning, and local governments having the wherewithal to independently develop and implement WCPs should not have undue difficulty navigating the revised approval process.

Comment 160: Several commenters suggested that NMFS should give more recognition to local watershed restoration efforts.

Response: NMFS recognizes the importance of local efforts, and will, by accepting approved watershed assessments, WCPs, and restoration projects developed through cooperative local efforts, acknowledge the contributions made by local watershed conservation groups. These efforts, in conjunction with regional and ESU-specific recovery efforts, will be crucial components of species recovery.

Comment 161: Several commenters pointed out that the assured funding criterion § 223.203(b)(8)(i)(A)(10) could present difficulties for some local governments and watershed councils.

Response: NMFS recognizes that securing funding to reliably implement the WCPs will be a challenging undertaking for many entities. Therefore, NMFS remains open to trying different means to flexibly deal with any difficulties that may arise—particularly with regard to funding.

Comment 162: One commenter objected to a requirement that WCPs be monitored to determine whether they increase listed salmonid productivity. The commenter was concerned that the cost and difficulty of monitoring fish populations would discourage local efforts at habitat restoration.

Response: NMFS realizes it is difficult and expensive to monitor population response and that acceptable methods have generally not been developed. While increased fish productivity is the ultimate goal (from NMFS' perspective) of a WCP, NMFS recognizes that monitoring programs will focus on habitat functions and processes as indicators of watershed health.

Comment 163: One commenter suggested that the **Federal Register** document and comment period prior to NMFS' approval of watershed conservation plan guidelines was unrealistic and contrary to the goal of salmon recovery.

Response: NMFS considers it necessary to provide for appropriate public review of the guidelines that NMFS expects to be addressed in programs submitted for its review. Ensuring complete and open public scrutiny will improve the guidelines through broad input and enhance their value through dissemination to all parties interested in the role of the guidelines in salmon recovery.

Comment 164: A number of commenters suggested there was a need for greater clarification in the scope and purpose of WCPs and watershed analyses, and that more specific direction was required in order to identify the information needs of the plans and analyses.

Response: Analyses and plans must ensure that habitat restoration activities will help place the overall habitat on a trajectory towards a self sustaining condition that provides high quality ecosystem function. NMFS believes that projects planned and carried out based on a watershed-scale analysis and conservation plan are likely to be the most beneficial. Watershed analyses identify problems that are impairing watershed processes and functions and supply base information needed to develop watershed plans and restoration activities. Without the context provided by watershed analyses, habitat restoration efforts are likely to focus on symptoms rather than on the underlying impaired ecosystem processes. NMFS identified 10 standards in the ESA 4(d) rule that characterize the WCPs' scope and intent.

Comment 165: Two commenters indicated that the restoration programs receiving limits on the ESA section 9 prohibitions should be expanded, and further, that the guidance should be made ESU-specific.

Response: NMFS works with state and local jurisdictions and other resource managers to identify programs for which it is not necessary and advisable to impose take prohibitions because they contribute to conserving the ESU or are governed by a program that adequately limits impacts on listed salmonids. This ESA 4(d) rule may be amended to add new limits on the take prohibitions or to alter or delete limits as circumstances warrant. NMFS wishes to continue to work collaboratively with state and local jurisdictions and other resource managers to recognize existing and potential management programs that conserve listed salmonids and meet their biological requirements. As more programs that meet these objectives are developed or identified, greater geographic and ESU specificity may be possible.

Comment 166: One commenter suggested that WCPs should be required to protect existing high quality habitat.

Response: NMFS agrees that the best available science supports the concept of protecting existing high quality habitat as a cornerstone of a WCP (provided there is high quality habitat within the scope of the WCP). But the criteria provided at § 223.203(b)(8)(iii) will be used only to evaluate state WCP guidelines, which will include much more technical detail. Those guidelines will then be used to evaluate WCPs.

Comment 167: One commenter stated that conservation plans should not be limited to salmonid recovery but must be broad enough to encompass other watershed functions and goals.

Response: In freshwater ecosystems, NMFS' legal authorities are limited to the conservation and recovery of listed anadromous salmonids and their habitats. To help conserve listed salmonids, restoration actions should put the aquatic habitat on a trajectory towards such a naturally self sustaining system (i.e., properly functioning habitat). Properly functioning habitat condition consists of the sustained presence of the natural processes that provide high quality ecosystem function. This complex system is composed of the stream, the riparian area, and upslope areas. All three components of this system are interconnected. The WCPs that guide restoration activities intended to conserve salmonids will also benefit other aquatic, riparian dependent, and upland species and their habitats.

Comment 168: Two commenters suggested that WCPs should also serve as CWA section 303 Total Maximum Daily Loads (TMDLs) for waters listed as impaired. Another suggested that NMFS work with the Oregon Department of Agriculture to coordinate the SB 1010 water quality management process with the watershed conservation planning process.

Response: NMFS believes these are excellent ideas and recommends the approach. However, NMFS does not deem it necessary for the conservation of the species to require such a consolidation of mandates in this final rule. Incorporating water quality management plans, such as SB 1010 plans or TMDL Water Quality Management plans, into the watershed conservation planning effort is a logical and pragmatic approach towards watershed-scale recovery.

Comment 169: Numerous commenters stated that the habitat restoration portion of the rule was too permissive and unclear in its objectives, definition, criteria, and implementation. One commenter believed it would create new programs that would divert attention from the loss of viable habitat which is the root cause of salmonid decline. Others cautioned against allowing state programs a limit on the take prohibitions because existing state programs have proven to be poorly designed and implemented. Several commenters noted general loopholes in the limits section.

Response: The six specific interim provisions of the proposed rule were intended to strike a balance between the possible benefit to listed salmonids of allowing incidental take associated with some habitat restoration activities (while WCPs were being developed) against the risk that those activities might have deleterious consequences that a WCP context would have prevented. To accomplish this, NMFS selected six categories of common and relatively low risk restoration activities, and provided specific guidance and a list of references to further reduce the risk. In light of the numerous comments asserting that the interim provisions were both too permissive and too restrictive, NMFS now concedes that attempting to strike this balance was overly ambitious, and so has deleted the interim provisions from the limit for habitat restoration. Instead, NMFS offers three approaches for individuals who are contemplating habitat restoration actions but are concerned about their take liability: (1) Many of the most effective long-term restoration activities (e.g., riparian livestock exclosure fencing, native vegetation planting, cessation of ground or vegetation disturbing activities, cessation of water diversion) have extremely low probabilities of take, and the actors should not be concerned about take liabilities; (2) most higher-risk activities (e.g., instream construction activities, modification of stream bed or banks) require a CWA 404 permit from COE which provides incidental take permission through section 7 of the ESA; and (3) NMFS recommends the habitat restoration limit on take prohibition included in this rule as the best solution for encouraging effective restoration activities consistent with science based guidelines.

Comment 170: A commenter suggested that the rule holds habitat restoration to a much higher standard (in some cases so high as to render such activities impossible) in terms of avoiding impacts than it requires for development activities.

Response: NMFS disagrees. As stated in the rule, all 13 of the limits contribute to the conservation of listed salmon or are governed by programs that adequately limit their impacts. Moreover the same standard applies to both habitat restoration and development activities; they must achieve PFC of the habitat.

Comment 171: Several commenters believe that NMFS' approach with this limit is to treat habitat restoration activities as a significant threat to the very species they are trying to protect. They believe that NMFS is overreaching its authority and this approach is bureaucratic, unrealistic, unnecessary, and will, as a result, be counterproductive to species recovery. Many stated that NMFS should give a limit to any activity carried out in accordance with state and Federal Laws. Another general sentiment was that NMFS should take a "hands-off" approach to restoration activities and simply provide landowners with technical expertise.

Response: We agree that bureaucracy should be kept to a minimum wherever possible and we will consistently seek ways to streamline all the processes this final rule entails. Nonetheless, the final rule includes a limit for habitat restoration activities because, absent the limit, some of these activities could result in prohibited taking. NMFS does indeed want to avoid the tragic irony of having a protective regulation impede habitat restoration that might otherwise contribute to recovery. However, good intentions alone will not adequately protect listed salmonids from the unintended negative consequences of poorly designed habitat restoration projects. Such projects often entail physical modification of currently used habitat of listed salmonids, and have significant potential to further damage impaired habitats and populations. The probability and consequences of project failure can be particular severe when projects attempt to redress the symptoms of habitat impairments before the underlying causes have been reversed. NMFS does not believe that it can disengage from its ESA responsibilities and simply rely on other state and Federal laws for approval to carry out restoration activities.

Comment 172: A few commenters stated that emergency exemptions and a specific scope of rules should be included for bank stabilization and flood repair operations.

Response: NMFS believes altering and hardening stream banks, removing riparian vegetation, constricting channels and flood plains, and regulating flows are primary causes of anadromous fish declines. Section 404 of the CWA—implemented through COE regulatory authority—provides conditions for permitting stream channel and bank activities. Section 7 of the ESA provides emergency consultation procedures which allow Federal action agencies to incorporate endangered species concerns into their actions during the response to an emergency (50 CFR 402.05). For these reasons, NMFS asserts that existing regulations are sufficiently flexible to enable emergency work without limiting take prohibitions for flood control or repair activities.

Comment 173: One commenter suggested that "artificial bank stabilization" should be defined.

Response: We agree that the usage in the proposed rule may have been confusing. The term is meant to be read in context with "primary purpose" of the habitat restoration activity definition. The primary purpose of the vast majority of bank stabilization projects is not to restore natural aquatic or riparian habitat processes or conditions, but to protect economic development and then try to "fix" habitat remnants in an artificial manner. Such use of artificial materials and means in a piecemeal approach to control a river (or enhance an already controlled river) clearly fits the definition of artificial bank stabilization.

Comment 174: Numerous commenters stated that marine and estuarine habitats should be included in the habitat protections and that connectivity issues and restoration activities should receive similar attention.

Response: NMFS agrees estuarine habitats should be protected, but believes the rule adequately prohibits take and destruction of habitat in marine and estuarine areas. This final rule text provides sufficient examples (i.e., destruction of freshwater and estuarine habitat, altering stream or tidal channels, altering habitat) as take guidance. Lists of how prohibited take may occur are not designed to be exhaustive. Regarding limits for habitat restoration activities in marine/estuarine areas, NMFS believes such projects are of large enough scale and complexity to require project by project technical review at least until watershed planning is complete. NMFS not only agrees with the commenters stating that near shore marine and estuarine habitats should be included in watershed planning but expects that these areas will be included in applicable state guidelines and WCPs.

Comment 175: A number of commenters requested that NMFS define the spatial scales appropriate for watershed analyses and conservation plans.

Response: NMFS recognizes that the four states covered by the ESA 4(d) rule delineate watershed boundaries using different hydrologic and administrative criteria. Consequently, the size of individual watersheds varies among the states and often across programs within a state, though there are a number of basic similarities in terms of watershed function and boundary. Each state's regulations and conservation programs are unique and the WCPs will most effectively conserve anadromous fish and their habitats if watershed boundaries are delineated within each administrative context.

Comment 176: A number of commenters indicated that the state guidance documents developed to help steer restoration activities were not complete or were not ESA compliant.

Response: NMFS recognizes that some of the identified state guidance documents are not finalized, and that some of the included activities may have an appreciable risk of taking. However, NMFS notes that these documents do provide guidance that will reduce risk and increase benefits of habitat restoration activities. Therefore, NMFS still recommends use of the guidance documents: Oregon Aquatic Habitat Restoration and Enhancement Guide (1999); A Guide to Placing Large Wood in Streams, Oregon Department of Forestry and Department of Fish and Wildlife (May, 1995); WDFW's Fish Passage Design at Road Culverts (March 3, 1999); and Oregon Road/Stream Crossing Restoration Guide (Spring 1999). Further, NMFS encourages the states to compile and expand these valuable guidance documents into WCP guidelines which NMFS may find qualifying under § 223.203(b)(8)(iii) of this rule.

Comment 177: Some comments reflected a concern that a report cited by NMFS in the proposed rule, "Steelhead Restoration and Management Plan for California" was not a peer-reviewed document and should not be included as guidance.

Response: The report cited in these comments has been adopted as an integral part of the Cal-Fed ecosystem plan, and was subject to extensive peer review before being adopted.

Comment 178: Several commenters questioned how the rule affected Indian Tribes' habitat restoration efforts. Most comments were directed at tribal participation in watershed planning, the potential for conflict between state guidelines and tribal restoration plans, and the lack of specific limits for tribal habitat restoration projects.

Response: As co-managers, the Tribes may participate in any forum for developing conservation guidelines and specific WCPs. Tribes may also submit their own watershed conservation guidelines and plans under the Tribal plan limit. This final rule text describes a process wherein four western states are tasked because NMFS believes the states are responsible for conserving natural resources and native species within their geographic boundaries, and that sufficient infrastructure is in place to expeditiously develop guidelines. No further or specific limits for tribal restoration projects were included in the rule because limits for tribal trust resource management actions that take threatened salmonids are promulgated in a separate rulemaking (65 FR 108, January 3, 2000).

Comment 179: One commenter requested that the removal of sinker logs (which can sometimes constitute a navigational hazard) should receive a limit on the take prohibitions.

Response: Removal of navigational hazards is under the authority of COE and it is their responsibility to consult with NMFS when they propose to engage in an activity that may affect listed salmonids. Federal projects that are approved through ESA section 7 consultation need not also qualify under a 4(d) rule limit.

Comment 180: One commenter suggested that physical fish habitat is not being fully utilized now, and questions the need to create more.

Response: NMFS respectfully disagrees and believes the commenter may have oversimplified the multifaceted problem of habitat productivity as being only a matter of finite capacity. This is a less-than-accurate portrayal of the habitat factors for decline which include both pervasive loss of habitat quality and loss of access to historic habitat because of barriers. It is NMFS' position that habitat degradation and loss have contributed substantially to the decline of anadromous salmonids, and opportunities to regain both habitat function and extent should be sought.

Comment 181: Some commenters felt NMFS should recognize that it may not be advisable or possible to protect or restore historic stream channels/processes, especially in urban settings.

Response: NMFS recognizes that, especially in the urban setting, stream channel habitats are often impaired and are not functioning properly. NMFS would further acknowledge that not all stream segments may be recoverable. However, NMFS maintains that all tools for salmon recovery must be retained in the toolbox. Urban development, open space, or green space designations provide opportunity to protect important riparian settings. Likewise, urban redevelopment may provide future opportunities for communities to protect or restore historically important stream channel settings.

Properly Screened Water Diversions

Comment 182: One commenter wanted to know who determines whether fish screens are adequate.

Response: The proposed rule states that NMFS' engineering staff will agree in writing that a diversion facility is screened, maintained, and operated in compliance with NMFS- approved Juvenile Fish Screen Criteria. The proposed limit has been revised based on public comments and by the fact that the projected workload associated with approving potentially thousands of water diversion facilities in four states has the potential to overwhelm NMFS staff resources. Consequently, this final rule has been changed to allow NMFS-authorized state agency engineers and screen inspectors to review and recommend screen design certifications and to allow NMFS-authorized screen inspectors to check screens for operational and maintenance compliance. This approval process will augment NMFS staff review. NMFS' Northwest Region (NWR) Juvenile Fish Screen Criteria have been adopted by the Columbia Basin Fish and Wildlife Authority (with participants from the states of Oregon, Washington, and Idaho) for use in waters with anadromous salmonids. NMFS' Southwest Region (SWR) Juvenile Fish Screen Criteria was developed in close coordination with CDFG criteria and the two sets of criteria are compatible. As a result, in all four states affected by this final rule, NMFS' Juvenile Fish Screen Criteria will form the basis for a design review and inspection program. It is proposed that a design specification check-off form and an operational screen inspection report form be developed and used consistently in the four states. NMFS will establish and maintain a data base to record who reviewed a particular screen design, when it was inspected, any problems associated with poorly designed screens being approved, and other relevant information. A key component of this process will be important training to certify inspectors and design reviewers. New language has been added to the regulation to reflect this change.

Comment 183: Some commenters stated that the final rule should acknowledge other screen technologies, especially non-conforming technologies, that have been demonstrated to meet or exceed levels of protection provided by technologies that do meet NMFS screen criteria.

Response: NMFS' engineering staff is frequently asked to assess other screen technologies that are not compliant with NMFS' screen criteria. As a result, NMFS staff has developed a standard protocol for evaluating non-conforming technologies, and has published an agency position paper titled "Experimental Fish Guidance Devices," November 1994, that can be found on the NMFS web page at www.nwr.noaa.gov/1hydrop/exp_tech1.htm. This position paper describes the process NMFS requires for a proponent of experimental technology to demonstrate that a particular non-conforming technology meets or exceeds the level of protection offered by a facility designed using NMFS' Juvenile Fish Screen Criteria. We are not aware of any non-conforming technology that demonstrably protects fish as well as or better than NMFS' criteria for the variety of operating conditions present at any typical water diversion site. If evidence is provided that a non-conforming technology exceeds the level of protection provided by NMFS criteria (as described in the position paper referenced above), NMFS would welcome and approve this technology.

Comment 184: One commenter stated that water withdrawal and diversion activities that take listed salmon should not be granted limits.

Response: The intent of the limit for a water diversion equipped with a screen constructed to NMFS' standard is to minimize take associated with diversion activities once water is diverted from the stream. NMFS intends to enforce the take prohibition for other forms of take that may be associated with water diversions (e.g., dewatering streams, building gravel push-up dams, or creating other passage impediments).

Comment 185: A few commenters stated that requiring screens on all diversions in the Sacramento Delta regardless of whether or not the particular diversion affects steelhead is unjustified.

Response: The intent of providing juvenile fish screen facilities is to minimize the prospect of take once the water has been diverted. It is extremely unlikely that it can be conclusively demonstrated that any particular diversion in a river basin containing listed steelhead will never entrain a listed steelhead. It may sometimes be true that listed fish are not present at a diversion site. It is more likely that—due to a variety of circumstances—the listed fish simply escape observation at a given site. This should not be construed as a total absence of listed fish at a site. It should also be remembered that fish are at critically low levels now and that their presence at diversions and other sites is likely to increase as we proceed with their recovery.

Comment 186: Some commenters asserted that agencies and individuals making good faith efforts to install screens should receive a grace period during which take prohibitions would not be enforced.

Response: NMFS acknowledges that certain complex screen facilities can take several years to finance, design, and construct. NMFS will, therefore, change the proposed rule to include a provision for addressing selected facilities on a case-by-case basis. In these instances, a facility will be eligible for approval under the limit if it has an approved design construction plan and schedule that includes interim operation measures to minimize take. In the event that this schedule is not met, or if a schedule modification is made that is not approved by NMFS engineering staff, or if the screen installation deviates from the approved design, the water diversion will be subject to take prohibitions. In all other cases, as stated in the proposed rule, NMFS will apply the prohibition against take and the limit is available to those who have their diversion facility approved and inspected as stated in this final rule.

Comment 187: One commenter stated that diversion activities that substantially benefit the public should be included in the limit.

Response: It can be argued that any diversion activity confers public benefit to one degree or another. However, water diversions are screened to protect fish and allow them safe egress from the diverted flow—an activity which has little to do with how much the diversion itself benefits the public. Therefore, it is not possible to grant a blanket approval for water diversions—regardless of the amount of benefit that may putatively accrue from an individual facility.

Comment 188: Several commenters asserted that NMFS' screening criteria are not well defined, have not received enough scientific review, and are not flexible enough.

Response: On the contrary, NMFS' juvenile fish screen criteria are extensively detailed and do include sufficient flexibility to deal with site-specific constraints and other concerns. There is no set of juvenile fish screen criteria in the world that is as well defined, or has undergone a higher degree of scientific scrutiny. In addition, NMFS' juvenile fish screen criteria are based on decades of operational experience that have yielded the best screen designs for salmonid protection in existence. Several state agencies have adopted NMFS' screen criteria and use them in water bodies containing anadromous fish. Lastly, extensive biological screen evaluations have revealed little or no injury to fish when testing screen facilities constructed to NMFS' criteria. This is a primary indicator that NMFS' juvenile fish screen criteria are the best option for protecting listed fish entrained by a water diversion.

Comment 189: One commenter suggested that screened diversions approved under the limit should be reviewed annually as to their physical condition.

Response: This is a good suggestion. NMFS agrees with this comment, and will seek to incorporate this issue into the check-off form and inspection process for a screen design and inspection program that NMFS be developed with the states.

Comment 190: One commenter stated that there should be no violation of the rule for inadequately screened diversions if no take can be proven.

Response: There are no liabilities under ESA if take does not occur.

Comment 191: One commenter thought that "enforcement official" should be replaced with "authorized officer."

Response: NMFS agrees with this recommendation and has made this language change.

Comment 192: One commenter stated that unscreened agricultural diversions in the Sacramento River delta are not the problem, and that NMFS should concentrate its efforts on the export pumps that dry up the river.

Response: Water diversions in critical habitat have the potential to take listed salmonids and, are therefore, subject to take prohibitions. Even properly screened diversions may take fish by drying up the river. NMFS intends to enforce take prohibitions against diversions that dewater river beds.

Comment 193: One commenter wanted to know if the limit applies to all diversions or just irrigation diversions.

Response: As stated previously, diversion of water in critical habitat has the potential to take listed salmonids and is therefore subject to take prohibitions. Thus the limit applies to all diversions that may affect the listed species.

Comment 194: One commenter identified the need for detailed operation and maintenance guidance if maintenance is to be a requirement in this limit.

Response: NMFS' engineering staff will provide this guidance in general for all juvenile fish screens and will develop site-specific operations and maintenance plans for sites with particular concerns. Our intent is to develop this guidance in conjunction with regional forums on screen activities (e.g., the Fish Screen Oversight Committee of the Columbia Basin Fish and Wildlife Authority). Both the general and the site-specific guidance will be included in the proposed training program for state-authorized officers.

Comment 195: One commenter wanted to know if the ESA 4(d) rule applies to temporary diversions during construction.

Response: NMFS will need to review each situation on a case-by-case basis and the answer will depend on the nature of the diversion. Some construction activities provide a temporary diversion around a construction site, and safely return fish and flow to the stream downstream of the site. Other activities may be required to provide a screen and bypass for a temporary diversion if biological review determines that the activity will place the fish at risk. These decisions will be made when developing a Biological Opinion on a particular in-stream activity.

Comment 196: One commenter urged NMFS not to apply the ESA 4(d) rule take prohibitions in areas upstream of fish barriers.

Response: The ESA 4(d) rule take prohibition applies to the land and ocean area within the 14 designated ESUs. All operators of water diversions within these ESUs need to review their activities and modify any activity that may take a threatened species.

Comment 197: One commenter noted that NMFS does not credit compliance with existing fish protection requirements, but appears to require continual updating to new fish screen standards and individual sign-off from NMFS staff that the screen complies. The commenter also stated that individual screen certification creates certain practical obstacles and NMFS should use this as an incentive and limit the take prohibitions on water use in general, not just on the physical diversion structure.

Response: The intent of the ESA 4(d) water diversion screening limit is to allow a water diversion to be made as safe as possible for listed fish species. Therefore, as new biological information becomes available, it may drive a modification in the screen criteria. Nonetheless, NMFS recognizes that it is unnecessary to retro-fit all existing screen facilities with new features every time new information comes to light because the criteria that are currently in place do an excellent job protecting all salmonid life stages. NMFS has updated their juvenile fish screen criteria only once in the last 11 years. The change came about as a result of new biological evidence that certain previously untested aspects of the old criteria did not adequately protect certain life stages of fish. While this set a standard for new installations, NMFS did not expect retro-fits of recently constructed facilities. NMFS intends to certify screen designs that meet the criteria in place at the time of construction—providing there is no evidence to show that the device is actively taking listed species. In addition, NMFS intends that when screen components need to be replaced due to wear, materials will be used consistent with current criteria. However, if a screen is installed that is out of compliance with NMFS criteria, no limit from the take prohibition will be allowed.

Comment 198: One commenter argued that the practical effect of the ESA 4(d) rules with respect to water diversions is to eliminate incentives for water users to screen their diversions.

Response: The intent of this limit is to offer diverters protection from take enforcement when fish are protected by a properly installed, well-designed, and well-maintained screen. There are clearly other issues (e.g., stream dewatering) that can not be solved by screen installation, and these activities will continue to diminish critical habitat and take listed fish and thus be subject to take prohibition.

Comment 199 : One commenter urged NMFS to apply this limit to water pumping devices as well as diversions.

Response: Water pumping devices are included in this limit.

Comment 200: One commenter wanted to know the details of NMFS' enforcement strategy for non-compliant screens and diversions.

Response: NMFS' enforcement strategy is specified in the section of this final rule entitled "Take Guidance." Unscreened water diversions that cause take of a threatened species are subject to NMFS take enforcement action.

Road Maintenance Activities

Comments Relating to the Oregon Department of Transportation (ODOT) Limit

Comment 201: Several commenters wanted the limit provided to the ODOT for the Routine Road Maintenance Water Quality and Habitat Guide Best Management Practices July 1999 (Guide) to apply to other cities and counties as well so they would not have to develop their own. Many of these commenters also requested that the limit be expanded to other jurisdictions and departments of transportation—with appropriate revisions to the best management practices (BMPs).

Response: There are two issues reflected in this and other road maintenance comments and NMFS has organized its responses accordingly. The first is that some local jurisdictions would like to adopt the ODOT manual without modification with the understanding that it will provide proper functioning habitat conditions. NMFS agrees that local jurisdictions can adopt the BMPs in the manual; however, the local maintenance programs will need to be examined further to assess any differences between them and ODOT's program and determine how those differences would affect the success in contributing to Properly Functioning Condition (PFC). Also, NMFS and ODOT have spent several years evaluating this program so that NMFS has a clear understanding of ODOT's ability to fulfill training, tracking, and reporting requirements. Other jurisdictions wishing to be covered under this limit would have to demonstrate their ability to make similar commitments and would also need to define the circumstances under which an individual BMP would not be followed.

The second issue pertains to the potential application of the limit to similar activities of other jurisdictions besides ODOT and Oregon cities and counties. NMFS agrees that under the conditions that meet or exceed those described above, the limit for routine road maintenance could be applied to other jurisdictions such as ports, other state transportation agencies, and cities and counties in other states which also, like ODOT, have programs that are determined to meet PFC. This final rule describes the procedure for public comment and determination of inclusion within the limitation on the take prohibition.

Comment 202: One commenter focused on how NMFS would respond if the ODOT program had compliance problems or if new information demonstrated that the program no longer provided sufficient protection. They stated that allowing ODOT to correct the matter "within a mutually determined period of time" was too vague a standard.

Response: NMFS agrees, and the wording of the rule has been changed to reflect this comment.

Comment 203: Some reviewers stated that the ODOT guide is completely inadequate to the task of protecting fish in that it allows far too many potentially harmful activities and contains far too much ambiguous language. Similarly a number of commenters asked that ODOT remove the "hedge" words ("where feasible," etc.) from the road maintenance limit.

Response: NMFS believes that the ODOT program, as designed, will adequately protect the listed species and their habitat. NMFS also intends this final rule to be somewhat flexible in terms of allowing combinations of measures that avoid or sufficiently minimize take. Further, this final rule has been designed to take into account a range of circumstances wherein hard constraints relating to physical, safety, weather, equipment, or other project aspects make it impossible to follow the BMP to the letter. In addition, ODOT has stated that the discretionary language will not be used for convenience or for ease of operation. Therefore, based on NMFS' working relationship with ODOT, we expect that the standard BMPs will be used in most circumstances and situations. To help ensure that this occurs, the ODOT crews will be extensively trained and NMFS will regularly review the program.

Comment 204: One commenter stated that the ODFW, not the ODOT regional environmentalist, should review ODOT activities and decide if they need a biological assessment. The commenter was concerned by the fact that the proposed rule seemed to mandate consultation with the regional environmental coordinator for any in-water work and that the regional environmental coordinator would not have the specialized knowledge to make good decisions during in-water work.

Response: The ODOT coordinates with the ODFW on all in-water work for ODOT bridge repairs, and usually the regional environmental coordinator is involved in the discussions as well. The "and/or" language is not intended to exclude the ODFW, but rather to exclude the regional environmental coordinator in instances where that office's participation is deemed unnecessary. Two ODFW biologists are assigned to coordinate exclusively with ODOT on transportation issues and work closely with ODOT regional environmental coordinators. In addition, district biologists assist ODOT on a variety of construction and road maintenance issues and projects.

Comment 205: One commenter stated that the final rule should allow NMFS to approve minor variations from ODOT procedures.

Response: NMFS will exercise reasonable judgement as to whether any minor adjustment in the ODOT road maintenance guidance requires formal approval from NMFS and, therefore, also warrants **Federal Register** publication and public comment. However to stay consistent with the spirit of the limit, any change that would affect the substantive protections the program provides for the environment will require a written approval. NMFS has clarified this point by adjusting the language in the rule.

Comment 206: One commenter provided multiple, detailed, suggestions and critiques of the ODOT program. Each suggestion (in quotations) is covered in the following discussion unless it is discussed in another response.

(1) "To the maximum extent possible, the manual should contain enforceable standards." *Response*: Based on NMFS' extensive review of the ODOT manual, we believe the standards described are enforceable. For example, the first BMP for surface work requires (a) eliminating diesel as a releasing or cleaning agent and using only environmentally sensitive agents, (b) using heat sources to clean tack nozzles, (c) carrying adequate erosion control supplies to keep materials out of water bodies, and (d) disposing of excess material at appropriate sites. All these are enforceable. The same is true for the great majority of the BMPs for other activities.

(2) "Protective and mitigation measures for work conducted outside of the BMPs should be required, and they should be described." *Response*: We agree with portions of this statement. NMFS is continuing to work with ODOT on its maintenance BMPs. In most cases, the changes would have only minor (short-term) or no effects on habitat or fish. In situations where not following the BMPs would adversely affect fish or their habitat, NMFS will work with ODOT to ensure appropriate alternative protective measures and mitigation are applied.

(3) "The manual should describe an effective, proactive, monitoring program for maintenance projects." *Response*: Page 3 of the guide describes ODOT's monitoring program and it is also described in the draft rule. Research is being conducted on several high-risk activities such as culvert cleaning, culvert replacements, and winter maintenance in order to gain more information about maintenance project impacts and develop better BMPs.

(4) "The manual should contain specific timetables for project reviews and manual updates." *Response*: The

manual can be revised by ODOT in consultation with NMFS at any time. The draft rule states that ODOT has committed to review the guide and revise as necessary, at least every 5 years. In addition, ODOT will annually make any necessary BMP modifications.

(5) "Terms not in common usage should be clearly defined." *Response*: Uncommon terms are defined at the beginning of the guide (pages ii through iv).

(6) "Effective erosion controls and a list of specific techniques should be defined, including a description of methods to be used during emergencies." *Response*: Erosion control measures are described as BMPs under each activity. Erosion control measures for emergencies are being developed under a programmatic biological assessment.

(7) "Mandatory work windows should be defined to protect vulnerable life stages of salmonids." *Response*: As stated in the guide (e.g., pages 8, 12, and 13), ODOT must use in-water work windows for all in-water work, unless the ODFW specifically agrees otherwise. The ODFW's in-water work guidelines are part of the guide, in Appendix C.

(8) "Criteria for the use of bioengineering methods should be described." *Response*: The guide states that bioengineering will be used where possible. The ODOT currently has multiple research projects focusing on the use of bioengineering to stabilize slopes; as the results of the research become known, NMFS and ODOT will develop criteria.

(9) "Riparian management zones should be defined by water type or the criteria used to determine riparian buffer widths [should be] identified." *Response*: Standard buffer widths are defined on page iv of the guide. NMFS determined that these widths provide sufficient protection from road maintenance activities. The standard buffers also are implementable by maintenance staff without requiring detailed knowledge of fish presence/ absence. Also, ODOT is developing detailed maps that identify sensitive resource areas based on criteria described in the draft rule; they will include information on overstory values, salmonid presence, spawning habitat, off-channel areas, etc. The maps will thus delineate areas where only certain activities may be allowed and the ODOT maintenance staff will modify their activities accordingly.

Comment 207: One commenter asked whether ODOT standards apply to all streams, just water quality limited streams, or just fish-bearing streams.

Response: The ODOT standards apply to all streams. The guide is a statewide document for all maintenance areas, even where no listed fish are present.

Comment 208: Several commenters stated that any routine road maintenance program should have been included in this limit. In particular, routine road maintenance under the Oregon Department of Forestry's Forest Practices Act was suggested.

Response: In the final rule, the limit for road maintenance is broadened beyond the ODOT and Oregon cities and counties to include other jurisdictions within and outside of Oregon based upon the ODOT's manual or which otherwise contribute to achieving or maintaining PFC. However, road maintenance for forestry roads will not be included because the road use and required BMPs are very different for this type of road.

Comment 209: One commenter stated that ODOT should provide criteria and steps to avoid, minimize, and mitigate all impacts when their guidance cannot be followed.

Response: The ODOT's manual is intended to avoid, minimize, and mitigate all impacts. NMFS chose to preserve ODOT's flexibility in choosing the most practicable methods for avoiding, minimizing, and mitigating for impacts because of ODOT's demonstrated commitment to protecting aquatic resources.

Comment 210: Several commenters requested the elimination of the requirement to prohibit any sediment input into the stream resulting from routine road maintenance activities.

Response: The ODOT routine road maintenance program does not prohibit sediment input into streams, although it presents measures to minimize and avoid the input.

Comment 211: One commenter stated that ODOT needs to allow for road repair during winter/wet seasons if emergency conditions dictate.

Response: The ODOT will implement BMPs when practicable, and is responsible for coordinating repair and mitigation measures with appropriate resource agencies in the event fishery or water resources are damaged during a response to an emergency.

Comment 212: One commenter requested that ODOT's program be removed as a limit because the tribes had not been given an opportunity to review it. They stated that the guide was not available for review through the notice.

Response: There were a total of 52 days to review the ODOT guide. It was available through the ODOT web site and the NMFS Northwest Region's website. This was cited in the **Federal Register** document within the section titled Electronic Access. Moreover, it is NMFS' intent to work closely with the tribes of the region to develop improved information exchange and consultation opportunities.

Comments on the Potential Application of the Limit to Other Jurisdictions

Comment 213: One commenter stated that the limit's requirements for developing an Memorandum of Agreement (MOA) under which road maintenance programs for other jurisdictions would be approved are not specific and should be revised to provide clear direction.

Response: NMFS intentionally did not provide a detailed description of what the MOA should include or how it should be prepared. The MOA was intended to provide the mechanism for negotiating with various jurisdictions about how to make sure that their program is equivalent to the effectiveness of ODOT program in contributing to achieving or maintaining PFC, including the tasks of training, tracking, and reporting, and how to best apply comparable measures identified in the ODOT guide. Based on this and other comments, NMFS has revised the regulatory language to require "a written agreement" rather than a formal MOA. That written agreement is intended to be flexible enough so there is no need to recreate a new maintenance program or amend the rule.

Comment 214: One commenter suggested that each jurisdiction seeking coverage under the limit for routine road maintenance should be able to develop its own BMPs.

Response: NMFS does not object to the use of BMPs that may be different from those presented in the ODOT guide. NMFS is satisfied that road maintenance activities in compliance with the ODOT guide and program contribute to achieving or maintaining PFC. NMFS expects that each jurisdiction seeking to apply the routine road maintenance limit to its program will clearly demonstrate how that program either applies equivalent measures to those specified in the ODOT guide or how it otherwise contributes to PFC. NMFS does not necessarily expect each jurisdiction to adopt the ODOT guide.

Comment 215: One commenter indicated that compliance and effectiveness monitoring and adaptive management are essential to ensure adequate protection of listed species. This commenter expressed concern that the monitoring may not be adequate and that without specific monitoring criteria and protocols, the ability to evaluate and modify conservation measures would be limited.

Response: NMFS agrees that monitoring is essential for assuring that the routine road maintenance programs are being properly implemented and that the outcomes are as expected (i.e., contributing to PFC). The monitoring and feedback approach contained in the ODOT program, while being somewhat non-specific, is practicable and can provide enough information to assess compliance and effectiveness.

Comment 216: NMFS received one comment requesting that the limit set standards for road restoration and maintenance, as well as goals for maximum road densities.

Response: This comment is referring to forested watersheds and watershed conservation plans. NMFS is addressing those areas primarily through ESA mechanisms other than the road maintenance limits of the rule (i.e., application of ESA sections 7 and 10 for Federal and non-Federal land management practices, respectively).

Comment 217: One comment stated that there should be no specific limits for roads—just the normal section 9 prohibitions. The commenter was concerned that erosion caused by steep slopes and incorrectly built roads could potentially harm listed salmon populations.

Response: NMFS agrees that soil erosion from road projects can have adverse effects on salmon populations and their habitats. However, the limit only applies to routine road maintenance activities; that is, road repairs that increase the material profile are not covered under the rule. Any activity for which a COE permit is required is not covered by the routine maintenance program and would, in any event, require a section 7 consultation. The ODOT's manual recognizes the problems associated with erosion and addresses erosion repair (MMS 122). To minimize impacts, ODOT requires that erosion repair work consider bioengineering solutions. The maintenance program requires that ODOT maintenance staff take precautionary measures on identified erodible areas—provided the measures can be safely applied. Taken together with other measures ODOT is carrying out (e.g., mapping landslide-prone areas throughout the Oregon coast), the routine road maintenance program protects threatened salmon and steelhead adequately to warrant a limit.

Integrated Pest Management (IPM) Activities in Portland, Oregon

Comment 218: Several commenters indicated that NMFS led them to believe that pesticides would not be considered in this rulemaking and that it was, therefore, unfair to proceed with a limit that accounts solely for the Portland Parks and Recreation (PP&R) program. It was generally expressed that various states, local entities, and agencies should be allowed their own limit on take prohibitions as they relate to pesticide use. Other commenters stated that the PP&R IPM program was inadequate because it was too ambiguous, did not list the actual amounts of pesticide being used, allowed broadcast spraying in riparian buffers, and did not adequately address all potential pathways of contamination.

Response: The PP&R IPM program received a limit at this time because it is a fully-formed, conservative program. NMFS' decision process was based on careful scientific review, investigation of potential pathways of contamination (specific to PP&R-planned activities), and analysis. NMFS concluded that PP&R's plan addresses potential impacts and protects listed salmonids to an adequate degree. A subsequent review process will be conducted one year after PP&R's plan is adopted, additional reviews will occur every two years, and appropriate adjustments will be made throughout the process. As NMFS noted in the preamble to the proposed rule rates of application in buffer strips under the PP&R IPM program range from 8 percent to 100 percent of the individual chemical label restrictions. Moreover, these chemicals are not applied annually, rather only as needed and only as the last resort for controlling unwanted vegetation. Use of the term "broadcast spraying" may be misleading. The listed chemicals must be applied at low pressure (which results in large droplets to reduce airborne mists), by hand wand, and only in the area where a dense broadleaf outbreak is occurring—not the entire buffer area.

NMFS believes that with restrictions such as the ones cited here, and looking at the program as a whole, it sufficiently protects the listed salmonids.

Comment 219: One commenter asked if the PP&R IPM was intended to apply to maintenance activities adjacent to all streams, just water quality limited streams, or just fish-bearing streams.

Response: The PP&R IPM applies to all waters—regardless of their designation (moving, water quality compromised, fish/non-fish-bearing)—associated with PP&R managed lands. The use of pesticides near flowing waters is more restricted than near still water (isolated ponds).

Comment 220: One commenter stated that the PP&R IPM should require public notice 48 hours before spraying.

Response: Currently PP&R does notify the public of tree spraying by posting signs in the affected area 24 hours in advance. Also, on any day other types of pesticides are being applied, signs are placed in the park and remain there until the application is complete and any product has dried. It should be noted, however, that this is essentially a public health issue and is, therefore, outside the scope of a rule making for threatened salmon and steelhead.

Comment 221: Several commenters stated that data generated by Oregon's pesticide tracking law should be integrated with the limit.

Response: We agree that it would be useful information. The PP&R's IPM requires an annual report to NMFS. When NMFS reviews PP&R's annual report it will take into account new scientific data on pesticides and their effects on listed fish (and the habitats that support them) when making its decision whether to continue with the program as written or require changes. Over the next year, NMFS will examine the question of whether incorporating the information collected through Oregon's pesticide tracking law (ORS 192.502, ORS 634.306, and ORS 634.372) into the review process would improve that annual analysis.

Comment 222: One commenter requested that NMFS clarify that the PP&R IPM applies only to city parks managed by PP&R.

Response: The commenter is correct. The PP&R IPM program limit applies only to activities conducted by PP&R in Portland city parks.

Comment 223: One commenter expressed concern that the list of chemicals does not appear to take into account chemicals already present in surface waters. It was also stated that NMFS needs to do more research on the impacts pesticides have on anadromous fish.

Response: NMFS agrees with the need for more research in this area. The NMFS Northwest Fisheries Science Center (NWFSC) has recently begun a research program to evaluate in greater detail the effects of pesticides in the environment and their effects on anadromous fish. This program will expand on earlier investigations by the NWFSC and will look at the sublethal effects, synergistic effects, cumulative effects, and effects of inert ingredients in pesticides in the aquatic environment. NMFS will work closely with EPA and state authorities which have primary responsibility for ensuring the proper use of these products under relevant Federal and state regulatory regimes. Should information come forward to suggest that the otherwise-lawful use of a pesticide harms listed salmonids and is in violation of section 9 or this rule, NMFS anticipates addressing the concern through amendment of this rule, a section 7 consultation with EPA, or corresponding discussions with responsible state authorities. NMFS will employ this approach rather than favor enforcement actions against an individual applicator for the otherwise lawful use of the pesticide. Similarly, if NMFS finds that a limitation on the prohibition against take for the use of selected pesticides is necessary and advisable for the conservation of listed salmonids, it may amend this rule accordingly. Through such a programmatic approach NMFS believes that it will be able to achieve an orderly and comprehensive analysis of the use of pesticides and their effects on listed salmonids.

Comment 224: One commenter suggested that the best approach to evaluating pesticide use under the ESA was a toxicological risk assessment protocol based principally on the dose-response theory. Under this approach, the commenter concludes that "there is no evidence that take of salmon or steelhead has actually occurred as a result of pesticide use." The commenter further asserts that under a program managed by the California EPA's Department of Pesticide Regulation (DPR), "there should be zero take of any listed fish, including salmonids under NMFS' jurisdiction" if the protocols developed by the DRP are followed.

Response: NMFS disagrees. The NWFSC has been actively investigating the sublethal effects of pesticides on listed salmonids for more than two years. This research is specifically tailored to examine pesticide effects on the life histories of anadromous fish in California and the Pacific Northwest, and is designed to reduce the considerable scientific uncertainty associated with pesticides. NMFS will use the data arising out of this process to guide future decision making under the ESA.

Comment 225: Several commenters felt the rules may unduly restrict the critical function of noxious weed control. It was suggested that NMFS may be discouraging lawful and environmentally beneficial use of pesticides and herbicides.

Response: NMFS recognizes the importance of noxious weed control. The final rule encourages development of local programs that conserve fish while placing priority on preventing pests (weeds, insects, disease) through non-chemical means. Noxious weeds may be controlled in a number of ways—both with and without the use of herbicides.

Comment 226: Some commenters asserted that a regional invasive species prevention program is needed—one that includes a protocol for addressing expedited responses to invasive species.

Response: NMFS agrees that a regional invasive species prevention program that includes response protocols would be beneficial. Such a program should be developed in cooperation with state and local government agencies, FWS, and EPA.

Comment 227: Several commenters stated that if a pesticide is used according to the directions on the label, or in compliance with various other state or Federal regulations, the applicator should receive a limit on the take prohibitions.

Response: Please see earlier responses on the same general subject. Currently, EPA has not consulted with NMFS on the use of pesticides and their impact on listed anadromous fish and their habitat. Therefore, applying pesticides in accordance with current label directives, EPA guidelines, or interim state measures for pesticide use, is not, de facto, exempt from the possibility of "take." EPA's Office of Pesticides Program will initiate consultation on a limited number of EPA-registered pesticides with NMFS SWR later this year and, depending on the outcome of that process, NMFS will continue to seek such consultations on registered pesticides. NMFS also hopes to begin consultations on those pesticides being considered for registration. In any case, NMFS recognizes that the above restrictions (labels, state guidance, etc.) constitute the only protective guidelines currently available to applicators. Therefore, NMFS will work with the responsible agencies to determine the extent to which restrictions on pesticide use need to be adapted to meet listed salmonid needs and, as that process goes forward, individual applicators may look to those agencies and NMFS to provide appropriate guidance in the future.

Comment 228: Two commenters suggested that NMFS should not rely on local solutions for pesticides, since three of the four states have laws preempting local pesticide regulation.

Response: The PP&R IPM program does not regulate pesticides. It directs the limited application of pesticides by a local government agency. NMFS is confident that PP&R has the authority to direct its application program.

Comment 229: One commenter asked that NMFS clarify its definition of a pesticide to include any substance that is considered an herbicide.

Response: The commenter is correct about the definition of a pesticide. According to EPA, the term "pesticide" includes all herbicides, insecticides, fungicides, rodenticides, repellents, disinfectants, and other compounds that kill, control, or otherwise affect pests. The final 4(d) rule will incorporate this definition for the term "pesticide."

Municipal, Residential, Commercial, and Industrial Development Limit

a. Clarification of Where and How This Limit Applies

Comment 230: Many commenters requested that the final rule clarify where and how "this limit" applies. One commenter asserted that the rule was so unclear as to require that the limit be removed entirely.

Response: NMFS has attempted to remove vague and confusing language from this final rule and to clarify where the limit applies. This particular limit is intended to apply to a broad range of planning efforts, ordinances, regulations, and programs (promulgated by city, county, and regional governments) that conserve listed salmon and steelhead by regulating or otherwise limiting activities associated with MRCI development. Some examples are wetland protection ordinances, shoreline management and development programs, and urban growth management plans. Such activities are not necessarily limited to "urban" areas, because city, county, and regional governmental jurisdictions extend to suburban and rural areas as well. NMFS has, therefore, clarified the intended scope of this limit by replacing the term "new urban density development" with "municipal, residential, commercial and industrial (MRCI) development" to signify activities undertaken by cities, counties, and regional governmental entities in urban, suburban, and rural areas.

Comment 231: One commenter requested that the ESA 4(d) limit for urban development be more streamlined than the process for developing and approving an HCP.

Response: Once local ordinances or plans are approved, the process of implementing MRCI development activities will be very streamlined. The responsibility for subsequent project review, approval compliance, monitoring, and enforcement will rest with the local jurisdiction. NMFS will review each project's monitoring plans; however, we will not have a role in individual project reviews. In addition, any subsequent ESA section 7 consultations for individual projects for which there is a Federal nexus should be greatly simplified because the consultation will be able to tier off the local jurisdiction's initial analysis. The initial ordinance approval process, while subject to the same review standard as a section 7 consultation or section 10 permit application (i.e., individual ordinances must allow for properly functioning habitat conditions) should be considerably more streamlined than the HCP process because the procedural requirements are less complex (e.g., implementing agreements and NEPA analysis are not required for programs under the take limit).

Comment 232: Several commenters questioned whether the limit applies to the redevelopment of areas that no longer support salmon, and recommended that development along piped segments of low gradient streams should receive a limit on the take prohibitions. Others contended that the rule should address current and ongoing impacts from urban developments.

Response: If a stream segment or aquatic feature does not currently and has not historically supported salmonids, the limit only applies to the extent that downstream areas which do support salmonids rely on appropriate input of ecological element (litter fall, gravel recruitment, cold water, large wood, etc.) from above to achieve PFC. As a local project goes through the permit process, the existing condition of a stream segment within a watershed and its contribution to the ecological conditions essential to listed fish must be taken into account when determining whether and how a redevelopment project meets the local ordinances. It is the local jurisdiction's responsibility to determine how ordinances are implemented during the redevelopment of degraded areas. At a minimum, the ordinances must delineate the process for considering the redevelopment of degraded areas.

Comment 233: Several commenters observed that recovering PFC in large urban core areas is unrealistic.

Response: PFC requires the maintenance of habitat functions essential to the survival and recovery of listed salmonids, wherever those requirements may be found. NMFS agrees that many of the rivers and streams that flow through heavily industrialized or otherwise developed city centers cannot practically be expected in the near-term to resemble a rural river reach in PFC. The concept of PFC recognizes and accommodates the fact that essential ecological functions may be different in spawning and rearing habitats often found in forested environments, for instance, than in migratory corridors, often found in urban settings. Nevertheless, the highly modified habitat in urban settings still must maintain certain ecological functions that remain crucial to the listed species' survival and recovery. In the long run, most parcels in existing urban areas will eventually be redeveloped and restoration opportunities pursued. Urban rivers and streams will thus gradually recover more and more habitat functions over the upcoming decades.

Comment 234: Many commenters contended that the rules should include any (not just new) development (or redevelopment) inside or outside of the Urban Growth Boundary (UGB) or Urban Reserve Area (URA) in any of the affected states. In addition, many others stated that the proposed rule does not adequately distinguish between what is expected of the various kinds of development and redevelopment.

Response: NMFS agrees with the commenters that it is the activity, not necessarily the jurisdiction, that must contribute to achieving or maintaining PFC and has renamed and modified this limit to apply to MRCI development.

Comment 235: Some commenters questioned the need to treat development limits for urban and rural landscapes differently. They argued for the need to accommodate mature urban areas to protect the rural areas.

Response: NMFS agrees that properly functioning habitat, as described in section § 223.203(b)(12)(ii) of the regulatory language of this final rule, must be found in both urban and rural landscapes and is the foundation of this limit. NMFS also understands, however, that development in rural landscapes often requires different considerations than it does in urban landscapes. It is true that some rural developments, such as destination resorts or high-density residential development along rural shorelines, are quasi-urban in nature and have similar effects on salmonids and their habitats. The reverse can also be true. Conserving and restoring functional habitats depends largely on allowing natural processes to increase their ecological function, while at the same time removing adverse impacts from current practices. Those functional requirements apply regardless of where or how development takes place.

Comment 236: Some commenters requested that NMFS make clear that simply because the rule references the Metro Functional Plan, it does not mean that local jurisdictions must follow that proprietary program.

Response: Metro's Urban Growth Management Functional Plan applies only to the Metro region, that is Clackamas, Multnomah, and Washington Counties and the 24 cities in the Portland, Oregon metropolitan area. In order to accomplish the Plan's goals, local jurisdictions will have to take a number of actions—primarily by changing local government comprehensive plans and implementing ordinances. Other jurisdictions wishing to apply for an ESA 4(d) limit must craft their own plans in the context of local circumstances. NMFS notes that Metro has not yet submitted its Urban Growth Management Functional Plan to NMFS for consideration as a limit to the take prohibition, nor has NMFS approved it for that purpose. If Metro applies for a limit under this final rule, it will be evaluated at that time using the review process described in this rule.

Comment 237: Some commenters stated that NMFS should not allow this limit for the Tri-County planning effort in Washington State because Tri-County's proposal is "business as usual," and because the Tri-County implementation process would take too long to provide for salmonid recovery. Others felt linkages should be created between the Urban Development limit and the watershed plans in the proposed Tri-County framework.

Response: NMFS strongly disagrees with the general tenor of this comment and continues to actively support and encourage the Tri-County process. Certainly the negotiations are addressing difficult and complex issues. NMFS remains hopeful that these negotiations will yield agreements consistent with the requirements of the ESA and the listed fish. If Tri-County applies for a limit under this final rule, it will be evaluated at that time using the review process published in this final rule.

Comment 238: One commenter urged NMFS to include a limit for the CALFED-Bay Delta Program and other California programs.

Response: Applying for a limit under the ESA 4(d) rule is a voluntary process. Any jurisdiction or organization may negotiate with NMFS to create a plan and submit that plan for consideration under the MRCI limit. Such entities are also encouraged to bring to the table other types of limits that could be covered in a subsequent 4(d) rule and develop other plans to conserve the listed species.

b. Local Government Cost and Staffing Resources

Comment 239: One commenter expressed concern that the cost of mandatory setbacks would discourage redevelopment of brownfield areas.

Response: Different jurisdictions have the flexibility to tailor riparian management areas in urban brownfield areas to match local needs and conditions, provided they result in properly functioning habitat conditions.

Comment 240: Many commenters expressed concern that smaller jurisdictions do not have the staff and resources needed to comply with the urban development limits. One commenter asked for an explanation of "adequate funding."

Response: Ordinances or plans under which activities will be evaluated must be shown to meet PFC as illustrated by the applicable 12 considerations listed in this final rule, including the fact that the jurisdiction in question must demonstrate that it has the ability to enforce, monitor, and fund its obligations under the ordinance.

c. Implementation of the 12 Considerations

Comment 241: Many commenters asked NMFS to clarify how the 12 considerations are to be implemented or applied. Some thought the rule was too cumbersome and onerous, and, therefore, should be delayed or phased in. Others requested that NMFS not allow a phase-in approach.

Response: As the rule describes, NMFS evaluates activities that produce or result in conditions on the landscape that contribute to properly functioning (habitat) condition. Under this limit, NMFS will analyze MRCI ordinances and plans and determine if they will affect a condition on the landscape that is important to essential habitat functions. NMFS will then determine if that effect actually results in conditions that are likely to provide essential habitat functions; if it does, then the ordinance or plan may qualify for a limitation of the take prohibition.

The 12 considerations described in the MRCI development limit describe specific considerations that NMFS will evaluate when looking at MRCI development ordinances and plans. They are based on current scientific understanding of salmonid biological requirements (e.g., Spence *et al.*, 1996; NMFS, 1996). By assessing these 12 considerations, NMFS expects to evaluate the ordinances' efficacy in attaining (or maintaining) essential habitat functions or properly functioning conditions in various physical settings.

Comment 242: Several commenters questioned whether the proposed rule requires compliance with all 12 considerations. Some stated that NMFS should not require that all 12 considerations in the urban limit be satisfied at once.

Response: NMFS acknowledges that in addition to the comprehensive Functional Plan being developed by the Metro regional government in Oregon, other local planning entities are making significant progress in developing innovative MRCI ordinances and programs (e.g., the efforts by the Tri Counties and Kitsap County in Washington State). Not all local or regional governments have the resources to assemble all of their relevant ordinances and planning provisions into a comprehensive MRCI growth management program. NMFS is willing to assist such entities by reviewing individual ordinances or regulations that local governments may choose to submit for consideration under this MRCI limit. NMFS will still apply the 12 considerations in evaluating the likelihood that any given ordinance or regulation will achieve properly functioning conditions for salmonid habitat, but will recognize that some criteria may be less relevant than others—depending on the scope of the particular ordinance.

Because NMFS has a relatively limited number of staff members to review a potentially significant number of individual MRCI planning ordinances, plans, and regulations, NMFS strongly encourages local and regional governments to assemble comprehensive planning packages such as Metro's Functional Plan. Not only is this a more expeditious and efficient approach, it results in a greater likelihood that the MRCI growth management program will protect the full suite of essential habitat functions. In any case, because staff resources are limited NMFS will generally give comprehensive plans rather than individual ordinances priority in the review process.

Comment 243: One commenter requested that NMFS state whether the Metro plan meets the 12 considerations.

Response: Metro has not yet submitted its Urban Growth Management Functional Plan to NMFS for consideration as a limit to the take prohibition, nor has NMFS approved it for that purpose. If Metro applies for a limit under this final rule, it will be evaluated at that time using the review process described in this final rule.

d. NMFS' Approval

Comment 244: Many commenters wanted to know how NMFS would approve applications for inclusion in the take limit. Some commenters suggested that NMFS needs to establish a rule with a minimum set of clear and objective performance standards. Other comments suggested that NMFS should work with state agencies to develop state programs that meet some or all of the limit in order to help small, financially challenged jurisdictions.

Response: The 12 considerations represent evaluation considerations that, if addressed, will help conserve listed salmonids. When a local jurisdiction has an MRCI ordinance or plan it believes will attain or maintain properly functioning conditions, it is encouraged to pursue approval. NMFS will work directly with that entity to develop a product that meets the listed species' needs. However, as noted earlier, local jurisdictions are strongly encouraged to assemble, to the greatest extent practicable, all relevant MRCI development ordinances, regulations, or plans into comprehensive packages that NMFS can review in total. Such an approach is not only more efficient, it has a much greater likelihood of ensuring adequate conservation of salmonid habitat conservation than do individual ordinances. Before approving any application, NMFS will publish a notice in the **Federal Register** announcing the availability of the application for public review and comment. The comment period will be not less than 30 days.

Comment 245: Some commenters desired to know what NMFS meant when it said it would evaluate the limit on a regular basis.

Response: NMFS anticipates that each limit will be monitored during the life of the plan to ensure that management actions are meeting their intended purposes. Specific management actions arising under the plan will be compared with the conservation objectives to ensure consistency with the intent of the plan. Annual monitoring reports will be required and formal plan evaluations will take place at broader intervals—though not greater than 5 years. These evaluations will assess the progress of the plan toward meeting PFC, determine if the management actions are making satisfactory progress toward achieving the stated objectives, ensure that the actions are consistent with current policy, check the original assumptions to see if they were correctly applied, assess whether the impacts were correctly predicted, ensure that the mitigation measures are satisfactory, and determine whether new data are available that would require altering the plan.

e. Level of Protection Provided

Comment 246: Many commenters asked NMFS to clarify what parts of the limit are binding and what are not.

Response: The final rule does not establish any binding requirements or regulations on any prospective applicants with respect to measures that must be followed to qualify for the take limit. Instead, the final rule defines both the considerations and the process NMFS will use when reviewing any particular ordinance or plan. Once NMFS has reviewed and approved a proposal for inclusion in the limit, the applicant is bound by the substantive requirements established in the subject ordinance or plan; these will be documented in the relevant monitoring, reporting, and enforcement provisions. The final rule clearly describes NMFS' authority to withdraw the limit in instances where the applicant does not diligently implement the approved measures.

Comment 247: Many stated that the Metro Functional Plan was far too restrictive; many others thought it not restrictive enough.

Response: The limit does not hold out the Metro Functional Plan as a standard. Metro has not yet submitted its Urban Growth Management Functional Plan to NMFS for consideration as a limit to the take prohibition, nor has NMFS approved it for that purpose. In fact, NMFS understands that the plan is not yet complete. If Metro applies for a limit under this rule, it will be evaluated at that time using the review process described in this final rule.

Comment 248: One commenter asked NMFS to identify and give take prohibition limits to land development activities that will not harm listed salmonids.

Response: Development actions that do not harm salmonids or their habitats are not affected by the take prohibition. It is not within the scope of this final rule to identify the vast number of activities (including many development activities) that do not harm listed species. However, unmanaged development activities could frequently frustrate attempts to meet the 12 evaluation considerations within this rule and commonly are among those that have historically destroyed or adversely modified critical habitats. On the other hand, activities that are carried out according to limits provided by this final rule are expected to adequately protect listed salmonids and contribute to their conservation.

Comment 249: One commenter expressed concern that giving local jurisdictions a ESA 4(d) limit would not, by itself, help enforce local actions necessary to conserve listed salmonids.

Response: Local jurisdictions are charged with developing and carrying out land use programs within the range of listed salmonids. Although those plans can be revised to be consistent with scientific information used to develop this limit, those same plans are still defined and administered through laws and regulations. Ensuring compliance with these laws and regulations is a key factor in making the plans successful. Eligibility for this limit, therefore, requires those plans to include effective enforcement programs and measures to educate local citizens, encourage voluntary compliance, and detect and address violations.

Comment 250: One commenter asserted that limits for urban development should be analyzed within the cumulative impact context.

Response: NMFS agrees that cumulative effects should be an important consideration in MRCI effects analyses. NMFS is aware that comprehensive MRCI development plans frequently will rely upon watershed scale efforts to achieve PFC by managing rural and agricultural activities in coordination with the cumulative effects of more-urban development. To the extent that NMFS must prioritize the evaluation process, comprehensive MRCI plans with relatively broader scopes of activities, authorities, effects, and geography (and therefore greater flexibility in dealing with cumulative effects) will generally be evaluated before plans with relatively smaller scopes. Applicants with smaller-scale plans should take particular care that their effects analyses take cumulative impacts into account.

f. Habitat Restoration

Comment 251: One commenter felt the new urban density development limit should require local governments to address habitat restoration and rehabilitation.

Response: This limit applies to jurisdictions that carry out development in a way that adequately limits impacts on listed salmonids or contributes to their conservation. Habitat restoration would be applicable when it is necessary to rehabilitate former poorly designed or implemented practices to achieve properly functioning conditions for listed salmonids within that jurisdiction. A specific limit for habitat restoration activities is provided in this final rule.

g. Scientific Justification

Comment 252: Some commenters assert that NMFS has not provided adequate scientific justification for this limit. For example, one comment requested that NMFS justify why the little remaining habitat is important to listed fish, and specifically, what evidence exists to support the need for vegetative cover for the entire length of a stream.

Response: Neither **Federal Register** documents nor U.S. Code is written in scientific style, with its thorough support of factual assertions through citations. Nevertheless, NMFS is confident that its conservation approach in the MRCI limit (and elsewhere in this final rule) is scientifically credible. As starting points for investigators, NMFS recommends Simenstad *et al*, 1982, NRCC, 1996, Palmisano *et al*, 1993, Gregory and Bisson, 1997, Spence *et al*, 1996. Essential features of salmonid habitats include adequate substrate, water quality, water quantity, water temperature, water velocity, cover/shelter, food, riparian vegetation, space and safe passage conditions In designating critical habitats, NMFS considers the following requirements of the species: (1) Space for individual and population growth, and for normal behavior; (2) food, water, air, light, mineral, or other nutritional or physiological requirements; (3) cover or shelter; (4) sites for breeding, reproduction, or rearing of offspring; and, generally, (5) habitats that are protected from disturbance or are representative of the historical geographical and ecological distributions of the species (65 FR 7764, February 16, 2000).

Vegetative cover is good for a number of essential habitat features such as water quality, water temperature, bank stability, stream complexity, cover/shelter, and food. In MRCI environments, the loss of riparian vegetation, coupled with reduced base flows, causes streams to heat up more during summer. In addition, the lack of large wood recruitment combined with increased peak flows heightens the severity of streambed scouring and downstream wood transport. This causes stream channel simplification and greater instability. In order to reverse the downward population trend for listed salmonids and steelhead, the structure and function of their aquatic habitats must be restored to whatever degree possible.

h. Specific Comments on the 12 Considerations

12.i.A. Siting Development

Comment 253: One commenter requested a definition of "area of high habitat value."

Response: This phrase refers to an area in a PFC, one that is better functioning than neighboring sites, or one with the potential to be fully restored. To achieve properly functioning condition and high habitat values within an MRCI area, new and existing riparian management areas need to be connected across land ownerships and political jurisdictions whenever land is developed or redeveloped, or brought into an urban growth boundary.

Development activities should be sited in appropriate areas. They should avoid unstable slopes, wetlands, areas already in a PFC, areas that are more functional than neighboring sites, and areas with the potential to be fully restored. A description of particularly sensitive areas is included in the Fish and Forest Report cited elsewhere in this final rule. Such sites include, but are not limited to, soils perennially saturated from a headwall or a sideslope seep or spring, permanent initiation points of perennial (stream) flow, alluvial fans, the intersections of two perennial streams. Development activities in any particular jurisdiction need to be open to coordination with adjacent jurisdictions to ensure landscape-scale conditions are providing essential habitat function.

12.i.B. Stormwater Management

Comment 254: Many commenters asserted that the stormwater consideration was poorly defined and urged that NMFS establish stronger and more specific stormwater standards. Others felt that NMFS should allow flexibility in regional performance standards and in areas where avoiding stormwater impacts is not feasible. One comment suggested replacing stormwater discharge language with specific methods for reducing development effects.

Response: NMFS believes that applying the same standards and considerations to all jurisdictions will not provide the most effective stormwater management because different methods will be more effective in different jurisdictions—depending on factors such as the existing land use in the subbasin or watershed, soil types, rainfall patterns, the degree to which the natural stream hydrograph has been altered, etc. NMFS will consider these factors, methodologies, and standards when reviewing city, county, and regional government ordinances for approval.

Comment 255: Some commenters stated that in an urban setting, it may not be advisable or feasible to protect or restore historic stream hydrographs and meandering processes. They asserted that the phrase "where feasible" should be added to stormwater and meander provisions.

Response: It is NMFS' intention to use the best available technologies to determine the most economic means to contribute to the achievement and maintenance of properly functioning conditions. NMFS believes this provision is justified by the need to significantly improve habitat conditions in a given MRCI area and thereby reduce the risks to listed species and ensure that they have an adequate potential for recovery. This can be accomplished by guiding land use practices on the watershed scale in order to reduce impervious surfaces, maintain forest cover, and natural soils. These conditions will, in turn, maintain essential habitat processes such as natural water infiltration rates, transpiration rates, stormwater run-off rates, sediment filtering, and provide hydrographic conditions that maintain and sustain listed salmonids. Where stream hydrographs cannot be restored, compensatory mitigation should be provided to offset the loss of habitat function. Mitigation may include stream corridor restoration by reestablishing pre-development hydrological regimes, controlling pollution sources, stabilizing channel morphologies, engaging in sediment remediation, restoring instream structure, and reestablishing riparian cover. Many of these activities may be guided by watershed scale planning and analysis which includes management of rural and agricultural activities.

Comment 256: Some commenters requested further clarification on peak flows and desired that NMFS place emphasis on biologically significant flows (i.e., water velocities suitable for juvenile fish) instead of peak flows.

Response: Changes in hydrological processes associated with the effects of MRCI development typically result in a flow regime that is more episodic and generates higher peak flows, faster runoff, and reduced base flows during periods without precipitation. Peak flows and base flows are both ecologically significant. Peak flows are primary agents of instream and riparian habitat change during storm events. Base flows sustain aquatic life during dry portions of the year. Other hydrological characteristics are also significant in the design of stormwater systems, for example, the need for water velocities suitable for juvenile salmonids.

Stormwater management programs associated with MRCI development activities should avoid impairing water quality and quantity. Such programs should preserve or move stream flow patterns (hydrograph) closer to historic hydrologic conditions (e.g., peak flows, base flows, durations, volumes, and velocities) that maintain properly functioning habitat conditions. This can be accomplished by guiding land-use practices at the watershed scale in order to reduce impervious surfaces, maintain forest cover, and retain natural soils. These conditions will, in turn, maintain essential habitat processes such as natural water infiltration rates, transpiration rates, stormwater run-off rates, sediment filtering, and provide hydrographic conditions that sustain aquatic life. NMFS will evaluate the effects that city and county ordinances (submitted for approval under this limit) have on relevant hydrologic processes.

12.i.C. Riparian Management Areas

Comment 257: Many commenters were concerned that the riparian management requirements were vague and uncertain. Some viewed this as creating opportunities to evade the intent of the riparian provision, while others wanted NMFS to make clear the fact that the intent was to be flexible and non prescriptive.

Response: The goal of MRCI riparian management is to protect and restore properly functioning riparian condition. To achieve this goal, programs must protect and restore soil quality—including controlling erosion and conserving soil productivity—and ensure that a diverse plant community with a vigorous age class distribution is well-distributed across a riparian management area. This contributes to the natural succession of riparian vegetation, produces habitat features essential to fish health, and protects water quality and flow conditions needed to meet fish habitat needs downstream. In MRCI areas, where riparian areas are usually subject to frequent and pervasive disturbance, the overland movement of nutrients, pesticides, and sediment can be pervasive. Thus, properly functioning MRCI riparian areas must also intercept and immobilize large pollutant loads, reduce runoff energy, and decrease the amount of nutrients being delivered to the streams. NMFS is not able to define the specific management strategies needed to achieve PFC in every conceivable situation involving a riparian area, particularly where a restoration component is necessary. The basic goal of riparian management is to establish management that allows the riparian area to proceed on a growth and succession pathway toward a mature riparian condition. As noted earlier, mitigation should be developed for functions that cannot be maintained or restored at the site level and may likely require watershed-scale planning. As several commenters requested, this allows different jurisdictions the flexibility to tailor riparian and wetland management to match local needs and conditions.

Comment 258: A large number of commenters addressed the appropriate width of urban riparian management areas. Many comments focused on management area width without regard for location, riparian composition, or management strategy. One comment noted that the width of the urban riparian management area was greater than for lands affected by the Washington forest practice limit.

Response: There are differences in ecological function among riparian areas in the MRCI and forest management settings. These include the relative importance of pollutant and runoff control, the distribution of nutrient cycling and energy flow, and the efficiency of natural recovery mechanisms. However, the need to define properly functioning condition based on the salmon's biological requirements does not vary by land use type.

NMFS' evaluations of MRCI development are significantly influenced by a body of science indicating that essential habitat functions are affected to varying (but significant) degrees by streamside activities conducted within a distance equal to the height of the tallest tree that can grow on that site (known as the site potential tree height). This was the basis for the example in the preamble to the proposed rule that used 200 feet (60.9 meters) as the approximate span of a site potential tree height. The distance is measured not from the stream itself, but from the edge of the area within which a stream naturally migrates back and forth over time (the channel migration zone).

NMFS believes that the most effective way to ensure PFC is to manage MRCI development activities in riparian areas so that their impacts on habitat functions are minimal at the streamside, but may gradually increase with distance from the stream. For example, the riparian area is often managed with two zones, an inner zone that has the highest level of protection and is managed primarily to provide stream function by avoiding disturbance, and an outer zone managed for both stream function and as a transition to more heavily used upland areas. The width of each zone should be commensurate with the functions they are intended to provide and, in MRCI settings, reflect the need to buffer an upland disturbance regime that may be more severe than in forest lands; e.g., more frequent entry by humans and domestic animals or exposure to large amounts of nutrients, pesticides, and sediment.

Comment 259: Several commenters supported a preference for using native riparian vegetation.

Response: NMFS agrees that to meet the final rule's intent, existing native trees and other native vegetation in riparian areas should be protected and native vegetation should be used for restoration plantings wherever appropriate native stock are available to meet the project needs. Non-native stock or seed should only be used after a good faith attempt has been made to locate native materials. If native materials are unavailable, ecologically functional equivalents that are known not to be aggressive colonizers may be substituted. When the scope of an MRCI redevelopment activity may include modifying a riparian site with existing, non-native vegetation, it may be important to restore native vegetation on the site in order to generate the essential habitat functions discussed above.

12.i.D. Stream Crossings

Comment 260: Several commenters requested clearer criteria for culvert installation and bridge crossings. Some wanted the referenced guidance document to be included in the final rule.

Response: Activities such as road and stormwater system design and construction or placement of utility corridors should avoid stream crossings wherever possible in order to prevent soil disturbance and sediment and flow problems in the stream. Where a crossing is unavoidable, the condition of the crossing should minimize its affect by preferring bridges over culverts; sizing bridges to a minimum width; designing bridges and culverts to pass at least the flow level and debris associated with a 100-year flood event; and meet ODFW or WDFW criteria (ODFW's Oregon Road/Stream Crossing Restoration Guide, Spring, 1999 and WDFW's Fish Passage Design at Road Culverts, March 3, 1999). These two documents will be included in a guidance document to be published by NMFS at the same time as this final rule.

Comment 261: Many commenters stated that new and existing linear facilities—such as utility corridors—that cross rivers and streams should be included in this section. Other commenters wanted the language "wherever possible" used in the sentence "avoid stream crossings by roads wherever possible" to be strengthened or deleted because it creates a loophole. In general, they desired that NMFS establish criteria to determine if a crossing is necessary.

Response: Linear facilities will be included in the stream crossing section of this final rule. As to the necessity of individual crossings, NMFS believes the city or county jurisdictions should perform the lead role in developing these criteria. The applicable state fish and wildlife agency can provide considerable guidance in developing these criteria—both through their existing codes and regulations and in their guidance documents (listed previously in this rule).

12.i.E. Channel Migration Zones

Comment 262: One commenter requested an explanation of the term "channel migration zone" (CMZ) and asked that it be linked to landscape features that developers and planners can understand.

Response: A CMZ is defined by the lateral extent of active channel movement along a stream reach over the past 100 years. Evidence of active movement over the 100-year time frame can be inferred from aerial photos or from specific channel and valley bottom characteristics and it was chosen for that reason. Also, this time span typically represents the time it takes to grow mature trees that can provide functional large woody debris to streams. A CMZ is not typically present if the valley width is generally less than two bankfull widths, is confined by terraces, no current or historical aerial photographic evidence exists of significant channel movement, and there is no field evidence of secondary channels with recent scour from stream flow or progressive bank erosion at meander bends.

Comment 263: One commenter requested that no bank hardening be allowed within the CMZ.

Response: Gradual bank erosion and meander migration within the CMZ are important ecological processes that provide geomorphic diversity and enable habitat development. Constructing rigid bank protection structures within the CMZ can prevent properly functioning conditions from being attained because it disrupts natural channel processes and initiates a cycle of altered erosion patterns flanked by new bank protection measures. The end result can be an entire reach being lined with rigid bank protection.

Where erosion within a CMZ is an issue, bank erosion should be controlled through vegetation, carefully bioengineered solutions, or other innovative "soft" bank protection techniques that allow eventual deformation by channel forming processes. Rip-rap blankets or similar hardening techniques should be avoided unless bioengineered solutions are not possible because of particular site constraints. NMFS finds that WDFW's publication, Integrated Streambank Protection Guidelines" (June, 1998) can provide sound guidance with respect to controlling bank erosion, particularly in the area of mitigation for gravel recruitment.

Comment 264: One commenter supported the concept of protecting the CMZ in streams and floodplains, and requested that the same protection be extended to prevent bank hardening in lake, estuarine, and marine shorelines.

Response: NMFS agrees that natural geomorphic diversity and habitat development are important in all fish-bearing waters, including estuarine and marine systems where the habitat formation processes of many wetlands, shorelines, and waterways have been impaired by the construction of dikes, levees, breakwaters, sea walls, shore protection systems, ports, moorages, and other hardened structures. While the CMZ concept itself is only applicable to systems with a definable channel, it is NMFS' intent to address, avoid, and minimize these habitat threats whenever such structures are constructed or maintained.

12.i.F. Wetlands

Comment 265: One commenter recommended that some wetlands be excluded from the take prohibitions and suggested that not every disturbance in a wetland management area should be prohibited.

Response: Take is prohibited. In general, MRCI development activities should protect wetlands and the vegetation surrounding them and thereby conserve natural wetland succession and function. The reason for this is that wetlands and their associated ecotypes support salmonid food chains, protect shorelines, purify water, store water during flood events, recharge groundwater, and provide specialized habitat for rearing and migrating salmonids.

Drained hydric soils that are now incapable of supporting hydrophytic vegetation because of a change in a water regime are not considered wetlands. The basic goal is to establish management that allows wetlands to maintain ecological functions, not to exclude all disturbances. Activities conducted in a wetland management area are generally subject to the COEs' permitting process under section 404 of the CWA and are necessarily subject to ESA section 7 consultation.

12.i.G. Hydrologic Capacity

Comment 266: Some commenters requested that NMFS clarify its intent in protecting hydrologic capacity.

Response: MRCI development activities should preserve intermittent and perennial streams' hydrologic capacity to pass peak flows. Decreasing the hydrologic capacity of stream systems by filling in the stream channel for road crossings or other development can increase water velocities, flood potential, and channel erosion, degrade water quality, disturb soils and groundwater flows, and alter vegetation adjacent to the stream. Preserving hydrologic capacity provides conditions needed to maintain essential habitat processes such as water quantity and quality, streambank and channel stability, groundwater flows, and riparian vegetation succession. Filling and dredging in stream channels should be avoided unless they occur in conjunction with an unavoidable stream crossing.

Comment 267: One commenter referred to the need to strengthen the Metro Title 3 flood management standards and ensure that riverine and floodplain systems are reconnected and historic floodplain functions are restored.

Response: Metro is currently seeking to improve Title 3 as part of a broader effort to comply with Oregon's statewide Planning Goal 5—the state's land use goal for natural resource and open space protection, and Oregon Administrative Rule 660, Division 23 (the "Goal 5 rule"). This effort is focused specifically on strengthening Title 3 by adding a program to protect, restore, and enhance fish and wildlife habitat functions in urban riparian corridors. NMFS is participating in a technical advisory role. Metro has not yet submitted its Urban Growth Management Functional Plan to NMFS for consideration as a limit to the take prohibition, nor has NMFS approved it for that purpose. If Metro applies for a limit under this final rule, it will be evaluated at that time using the review process described in this final rule.

12.i.H. Landscaping

Comment 268: Two commenters suggested more stringent standards for landscaping. One commenter proposed that watering, as well as fertilizers, pesticides, and herbicides, be eliminated in urban landscapes; the second proposed regulations requiring the use of native vegetation to reduce water use.

Response: Residential and commercial landscaping can be designed, installed, and maintained to reduce the need for water, herbicides, pesticides and fertilizer. Doing so will help maintain essential habitat processes by conserving water, reducing flow demands that compete with fish needs, and decreasing the amount of chemicals that contribute to water pollution in streams and other water bodies that support salmonids. NMFS relies on local ordinances to address planting and water use.

12.i.I. Erosion/Sedimentation

Comment 269: One commenter asked that NMFS clarify its expectations for erosion control measures.

Response: MRCI development activities should prevent erosion and sediment run-off during and after construction and thus prevent sediment and pollutant discharges. At a minimum, these activities should include detaining flows, stabilizing soils, protecting slopes, stabilizing channels and outlets, protecting drain inlets, maintaining BMPs, and controlling pollutants. This can be accomplished by applying seasonal work limits, phasing land clearing, maintaining undisturbed native top soil and vegetation, etc.

12.i.J. Water Supply/Screening

Comment 270: Several comments called for caution and flexibility concerning water supply development and water diversion screening; others wanted specific restrictions not identified in the proposed rule or mandatory conservation measures for existing developments.

Response: Water supply development can profoundly affect surface and groundwater hydrological processes. Water supply demands should be met without impacting flows needed for threatened salmonids—either through direct withdrawals from the streams or through groundwater withdrawals. Water diversions should be positioned and screened to prevent salmonid injury or death. When existing regulations do not protect the stream flows that salmon need, appropriate additional measures will need to be identified before NMFS approves an MRCI development ordinance.

12.i.K. Enforcement, Funding, Reporting, etc.

Comment 271: Several commenters supported the monitoring provisions and requested that specific monitoring and implementation programs be described. In contrast, others concluded that by including all necessary enforcement, reporting, and implementation mechanisms NMFS has the potential to be arbitrary in its review of programs. It was suggested that NMFS make the reporting requirement biennial instead of annual.

Response: During the ordinance or plan development and approval process, NMFS will work closely with the local jurisdiction to identify and develop those monitoring mechanisms applicable to the listed species, their habitat, and the local jurisdiction. The existing condition of the salmonid habitat in the watersheds, the rate of projected growth, and other factors will be used as a baseline for the monitoring.

12.i.L. Comply with Other State and Federal Laws

Comment 272: Some commenters wanted to exclude this provision because they believed it exceeded NMFS' authority and because other programs exist to assure compliance.

Response: This subsection notifies applicants of the continuing obligation to ensure that their developments comply with existing state and Federal rules and regulations, as well as with this final rule in order to be eligible for the limit to the take prohibition. Further, an applicant should automatically assume that compliance with the this final rule necessarily meets existing regulatory requirements of local and state agencies.

Forest Management Activities in Washington

Comment 273: Many commenters wanted to know how the April 29, 1999, Forest and Fish Report (FFR) process under section 4(d) of the ESA compares with the process for issuing an incidental take permit issued under section 10. Some of these commenters misunderstood the intent of the FFR and others mistakenly believed that the proposed limit could result in issuing an incidental permit, or could be in effect for 50 years.

Response: While an ESA section 10 HCP may be developed by a non-Federal entity using many of the elements of the FFR, that process has not yet progressed to the point that NMFS has become involved. In other words, it would be many months before anyone applies for an HCP based on the FFR. At this time, NMFS is simply describing the circumstances in which an entity or actor can be certain it is not at risk of violating the take prohibition or of consequent enforcement actions, because the take prohibition would not apply to programs within those limits. And, unlike an HCP with "No Surprises" assurances, under the 4(d) limit NMFS may require FFR to be adjusted in the future. For habitat-related limits on the take prohibitions, changes may be required if the program is not achieving desired habitat functions, or where even with the habitat characteristics and functions originally targeted, habitat is not supporting population productivity levels needed to conserve the ESU.

Comment 274: Some commenters wanted to know what role NMFS played in developing the FFR. Some commenters believed that NMFS had already approved the Washington State Forest Practice Emergency Rules without following the National Environmental Policy Act (NEPA), and other commenters wanted to know how NMFS interacted with other resource agencies.

Response: Along with other natural resource agencies at the state, tribal, and Federal levels, NMFS participated in multi-party negotiations with representatives of the commercial forest managers in Washington State from about April of 1997 through April of 1999. NMFS staff provided technical assistance to several of the work groups tasked with providing the scientific underpinnings for various elements of the FFR. Also, NMFS staff helped explain ESA procedures and implications to the entire negotiating group.

While NMFS considers the product of those negotiations—the FFR—to form the core of the ESA 4(d) limit for forestry on non-Federal lands in Washington State, the report will continue to be worked on for at least another year as various sections are refined and completed. Since the FFR was initially published in April of 1999, NMFS staff have made technical and policy contributions to many sections of the report. These include, but are not limited to, FFR "Schedules" (essentially, technical appendices) for Channel Migration Zones, Road Management, Placement of Large Woody Debris, Conversion of Hardwood Riparian Zones, Adaptive Management, and Resource Objectives. Some of these products are formalized as Washington Forest Practice Board (WFPB) Manuals associated with the Emergency Forest Practice Rules (that became effective March 20, 2000) and have been evaluated by the Department of Natural Resources (DNR) in their State Environmental Policy Act Draft Environmental Impact Statement (SEPA DEIS). This document may be found on the web at www.wa.gov/dnr/htdocs/fp/fpb/pdfiles/>.

Comment 275: Many commenters stated that the FFR was severely flawed. As evidence, they pointed to a critique organized by the Society for Ecological Restoration.

Response: Four individual scientists participated in a review of the FFR that the Society for Ecological Restoration (SER) organized. The American Fisheries Society (AFS) was solicited to review SER's material, but contrary to purported statements on behalf of SER, AFS did not review or endorse any of the reviewers' work products. The AFS repeatedly asked the SER to retract and correct this inappropriate attribution. NMFS believes that, while there are useful parts of the report, the Society's critique of the FFR was flawed by: (1) a limited understanding of the policies, regulations and intent of the ESA (2) an incomplete understanding of all the elements of FFR, which led to (3) overstatements of the perceived weaknesses in the FFR.

Specifically, the report claimed the FFR could result in: too-warm waters flowing from some non-fish bearing streams into fish-bearing waters; a failure to identify some small fish-bearing streams; inadequate assessment of some potentially unstable slopes; potential increases in peak-flows that could generally harm incubating fish eggs; a potential reduction in future recruitment of woody material from some non-fish-bearing streams into fish-bearing streams; excessive disturbance and potential delivery of sediments from some non-fish-bearing streams into fish-bearing streams; and, inadequate identification of impaired watershed conditions that may need extra protection. NMFS has assessed all these concerns in light of the best available scientific and commercial information and generally agrees with the environmental analysis summarized in the SEPA DEIS. The moderate environmental risks and levels of uncertainty associated with the FFR are directly addressed by the adaptive management program and the adjustable nature of the ESA 4(d) limit.

Comment 276: Several commenters wanted pesticide application covered in the FFR 4(d) limitation while another commenter did not.

Response: The FFR proposes certain guidelines for pesticide applications which can be found at: www.wa.gov/dnr/htdocs/fp/fpb/forests&fish.html#APPE. Due to the lack of information on specific pesticides proposed for use under the FFR and their potential for lethal and sub-lethal effects on fish or, as one commenter put it, an uncertainty that needs to be addressed, the limitation associated with the FFR does not include pesticide application.

Comment 277: Many commenters questioned how NMFS could ensure that the riparian conditions essential to listed fish survival and recovery would continue to function properly. Other commenters asked for a clear description of Desired Future Condition for riparian forests. Some commenters asked that NMFS prepare forest management standards for watersheds.

Response: The riparian conservation elements in the FFR are expected to play a major role in conserving salmonids and creating properly functioning conditions on non-Federal forest lands in Washington State. The FFR offers detailed, protective management strategies for three different forest land ecotypes in Washington as well as for fish- and non-fish-bearing streams throughout the state. NMFS has carefully examined these protections and management strategies and has determined that they sufficiently conserve the listed salmonids and will promote properly functioning habitat condition wherever they are applied. The best place to examine these management measures is in the FFR itself.

Comment 278: Many commenters expressed the need to improve forest road management and desired to know how the question was addressed in the FFR.

Response: Forest roads have the potential to affect aquatic ecosystems primarily by: generating and delivering fine sediments from road surfaces and ditches; delivering catastrophic sediment inputs as a result of road-related slope failures; blocking fish passage; disrupting the downstream routing of sediments and organic materials; reducing floodplain function; and modifying hydrologic patterns (e.g., the timing and intensity of peak flows). The FFR addresses all of these effects through a revised set of BMPs that govern road construction and maintenance. The BMPs require road maintenance and abandonment plans, set a functional resource objective for hydrology that virtually disconnects road drainage from stream systems, and describe a functional resource objective for road-related fine sediment that limits the length of ditch line that can deliver sediment to streams. Moreover, the FFR addresses existing road problems by requiring every forest landowner to produce a Washington State DNR-approved Road Maintenance and Abandonment Plan by 2005.

Comment 279: Many commenters did not believe that FFR or the Emergency Rules offered enough protection with regard to unstable slopes to meet the intent of the proposed limit.

Response: The goal for managing unstable slopes is to avoid increasing or accelerating the naturally occurring landslide rate (and volume) in forested watersheds, while still recognizing that mass-wasting is an essential watershed process element that helps route large woody debris through the stream system. The FFR provides general guidance about slope hazard by identifying four primary groups of land forms generally understood to be at risk for failure and potential sediment delivery: (1) Inner gorges, convergent headwalls, and bedrock hollows steeper than 70 percent; (2) toes of deep-seated landslides with slopes steeper than 65 percent; (3) groundwater recharge areas for deep-seated landslides in glacially formed terrain; and (4) the outer bends of meandering channels. The FFR lays out a detailed process for scrutinizing any proposed forest management activities in such areas and commits to support a team of geologists that will map any other potentially unstable areas in the state. NMFS has carefully considered these and the other basic protections set forth in the FFR and believes that the overall approach fits with the limit. Moreover, the risk from unstable slopes is expected to decrease as the adaptive management process moves forward and more and better tools are brought to bear on the problem of avoiding sediment inputs.

Comment 280: Some commenters stated that the FFR used a faulty system of stream-typing. They were concerned that an out dated system would continue to be used and, as a result, some fish-bearing streams might not be identified for protection.

Response: The FFR classifies streams and dictates levels of riparian and other protections based on the potential for a given channel to support fishes of any species at any time of the year. Seasonal fish-bearing streams are protected as if they were perennial. This habitat-based stream typing will replace the current emergency rule as GIS-based stream habitat models are developed (they are expected to be complete by June of 2001). For now, the older stream typing system—based on fish presence—will continue to be used; though it will also be upgraded through the WFPB Emergency Rule (March 20, 2000). Both of these stream-typing systems are based on judgements of the geographic threshold of perennial flow. These are considered to be: a sub-watershed of 13 acres in western coastal Washington, 52 acres in all other regions of Western Washington, and 300 acres in eastern Washington.

Comment 281: How does the FFR address potential changes in watershed hydrology resulting from forest practices? Some commenters thought NMFS should add provisions that would help maintain natural hydrology by limiting clear cut areas. Others urged NMFS to set standards for tree regrowth to aid watershed recovery after logging.

Response: The FFR proposed that forested watersheds be managed to meet a functional Resource Objective (Schedule L–1, in the FFR) that limits increases in peak flows and other consequences of altered hydrology. This Hydrology Resource Objective is still undergoing development. When complete, it will provide both a quantitative approach (based on changes in peak flow intensity or duration) and an objective based on the actual streambed effects arising from altered hydrology to choose from—depending on which is appropriate to the area in question. In both cases the emphasis will be on those watershed portions susceptible to rain-on-snow events, which are widely considered to have the greatest potential to alter peak stream flows and cause scour.

The BMPs for roads are also closely related to this issue (see earlier discussion for road-related hydraulic and sediment effects). In addition, the parties to the FFR committed to revising the Hydrology Module in the Washington Forest Practice Board's (FPB's) Watershed Analysis Methodology in order to more accurately assess hydrologic effects. Finally, the DNR also maintains authority to place conditions on any proposed Forest Practice if there is cause to believe that altered hydrologic conditions are of concern. Therefore, NMFS does not believe it necessary at this time to proposed additional conservation measures relating to watershed hydrology.

Comment 282: Many commenters wanted to know how NMFS would monitor activities under the FFR and use that data to determine whether rule adjustments were necessary.

Response: The FFR proposes an elaborate process for designing and implementing a monitoring and research program that will be used to adapt forestry activities through changes in the Washington Forest Practice Rules.

The adaptive management process is presented in Appendix L of the FFR. Essentially, the protocols and procedures for conducting adaptive management research and monitoring must be approved by Washington's FPB. An administrator employed by Washington DNR will oversee the program and assist the FPB in its task.

Comment 283: Many commenters stated that the FFR was too cumbersome for the Washington DNR to be able to implement.

Response: The Washington Forest Practices Board described their version of FFR, as Alternative 2, in the space of about 18 pages in the SEPA DEIS. The agency responsible for ensuring compliance with state Forest Practices—the Washington DNR—was a full participant in the negotiating process that led to FFR development. Part of their role was to codify and implement the proposed conservation measures. The first step of that codification was completed in February, 2000, when the FFR was substantially instituted as "emergency rules" for state forest practices. All necessary Washington DNR staff have undergone extensive training to implement the Emergency Rules.

Comment 284: Several commenters were concerned about the level of protection provided to wetlands, specifically forested wetlands. Other wetland concerns revolved around potential impacts on hydrology and water temperature as a result of effects on groundwater in up-slope areas. Also, some commenters indicated that the CMZ definition was too narrow and would not provide adequate protection.

Response: NMFS agrees there is uncertainty associated with forest management activities near wetlands in terms of how those activities might impact fish habitat. NMFS generally agrees with the analysis provided in the Washington State SEPA DEIS, section 3.5.2. That document can provide commenters with further information about the effects certain activities may have on wetland areas. In addition, the rule outlines the process for adjusting itself—a process that may be necessary as new information on the effects of specific forest practices comes to light.

The March 2000, Board Manual for Emergency Rules, section 2, explains the standard method for measuring CMZs and offers revised Standard Methods guidance. In it, several different ways of determining the CMZ are described, e.g., using historic aerial photographs, intensive field exercises, and field review by a channel expert.

Comment 285: Several commenters wanted the limit to include alternative plans that would give landowners managing areas less than 20 acres in size more operational flexibility. One commenter asked for clarification and requested that the limit include alternative plans that would help avoid any take liability.

Response: Within the construct of the FFR, alternate plans for forest management are allowed provided that the effect of these actions, as judged by the Washington DNR, conserves physical and biological processes at least as well as the base prescriptions. The purpose of this allowance was to address unique sites and operational configurations that required some departure from standard approaches. The alternative plan management strategy must protect public resources at least as effectively as the basic rules. If approved, the prescriptions set forth in an alternative plan would be substituted for the prescriptions in the corresponding basic rules. NMFS includes in this limit only those alternative plans in the FFR that have been demonstrated to adequately protect listed salmon, and that provide NMFS—or any resource agency or tribe NMFS designates—review opportunity at every stage of development and implementation. Such review may cause a plan to be excluded from this limit.

Comment 286: Many commenters asserted that NMFS had no scientific basis to expect that the limit would contribute to salmon recovery.

Response: As the proposed rule states, "this proposed rule restricts application of the take prohibitions when land and water management activities are conducted in a way that will help attain or protect properly functioning habitat. Properly functioning habitat conditions create and sustain the physical and biological features that are essential to conservation of the species. Properly functioning habitat conditions are conditions that sustain a watershed's natural habitat-affecting processes (bedload transport, riparian community succession, precipitation runoff patterns, channel migration, etc.) over the full range of environmental variation, and that support salmonid productivity at a viable population level." After carefully evaluating the various components of the FFR—as described in the proposed rule and discussed in pervious responses, NMFS has concluded that applying the FFR will help maintain and attain properly functioning habitat conditions and will, therefore, contribute to recovery.

Comment 287: A number of commenters suggested that NMFS should include the state forest practice rules from Oregon, California, and Idaho in the limit.

Response: At the time the limit was proposed for the FFR in Washington state, NMFS had not been presented with any other forest practices regulatory framework that was designed to conserve listed anadromous fish. For several years, NMFS has been discussing with state agencies in Oregon and California ways to strengthen the fish conservation aspect of forest practice rules in those states. NMFS wishes to continue working with all affected governmental entities in strengthening, identifying, and creating management programs that fulfill the listed salmonids' biological requirements. For programs that meet those needs, NMFS can provide ESA coverage through 4(d) rules, section 10 research and enhancement permits or incidental take permits, or through section 7 consultations with Federal agencies. A 4(d) rule may be amended to add new limits on the take prohibitions, or to amend or delete limits as circumstances warrant.

General

Comment 288: A broad array of interests asserted that their activities were, at most, only minimally harmful to salmonids and that natural environmental fluctuations and activities being conducted by others were responsible for the recent drastic declines in salmonid numbers throughout the Northwest and California. Among the activities and causes listed as most harmful were logging, grazing and other agricultural practices, pesticide use, various habitat-altering actions, urban development, sport fishing, commercial fishing, drift net fishing, tribal fishing, recreational fishing, ocean and estuarine conditions, hydropower development, marine mammals, avian predators, other predators, and so forth.

Response: Comments of this nature have been made in response to essentially every listing and critical habitat proposal NMFS has put forth over the last decade. As a result there is a great deal of information on these factors available in any one of a number of **Federal Register** documents and it need not be repeated in detail here. Nonetheless, it should be pointed out that the very number of commenters and the range of the causes cited are themselves indicative of the breadth and depth of the problems facing Pacific salmonids. Therefore, NMFS acknowledges that all of these factors have played a role in the species' recent declines; as evidence, most of the factors that commenters identified were specifically cited as risk agents in the West Coast Chinook Salmon Status Review (Myers *et al.*, 1998).

The two primary themes that repeatedly arise in these comments revolve around whether the massive declines in salmonid abundance are brought on by natural conditions or human alteration of the environment. NMFS recognizes that natural environmental fluctuations and increasing numbers of natural predators have recently had negative impacts on the species. However, NMFS believes human-induced impacts (e.g., harvest and widespread habitat modification) have played at least an equally significant role in the salmonid declines up and down the West Coast. And because the very nature of this rule-making—the codification of take prohibitions and the limits placed on them—cannot apply to natural processes (by definition, the ocean cannot not "take" species), the rules necessarily address human activities.

Comment 289: Many commenters stated that the language of the rules needed to be more clear in a number of respects, particularly with regard to the terms found in the take guidance sections. Others felt there was too much detail in the rules and that NMFS should simply stick to principles and not offer too much in the way of specific guidance.

Response: In publishing the proposed rules, NMFS tried to strike a balance between these opposing views. The point was to avoid making the rules overly prescriptive—and thus allow local initiative to play a strong role—yet still give valuable guidance on how to proceed with numerous human activities in the areas inhabited by threatened salmonids. To continue in this spirit, NMFS has gone to some lengths to clarify the guidance language and it may be found in this final rule.

Comment 290: Several commenters requested clarification on NMFS' use of the term "stock," the definition of population segments, and the implications of these concepts for species conservation.

Response: The use of the term "stock," following Ricker's definition, is critical because it defines the appropriate management units for conserving the species. According to Ricker, stocks are made up of numerous populations which become uniquely adapted to specific environmental conditions, leading to local variations in morphology, behavior, and life history traits. As amended in 1978, the ESA allows the listing of "distinct population segments" where groups of populations are assembled for conservation management purposes. NMFS' policy states that a salmon population is considered "distinct" for purposes of the ESA if it represents an ESU of the biological species, where an ESU represents an important component of the evolutionary legacy of the species. Thus the health of an ESU depends upon the health of its component parts. This argues for developing protective regulations across an ESU's entire range, even though some local populations may be thriving. The ESA 4(d) protective approach offers the flexibility to develop local protection programs which are cognizant of the species condition in the area.

Comment 291: A large number of commenters voiced general and specific support for and opposition to various rules.

Response: The proposed ESA 4(d) rules generated an amount of substantive public comment unprecedented since NMFS first began rule-making activities for salmonids on the West Coast 10 years ago. Many thousands of individual comments contained within the letters from well over one thousand respondents reflected the broadest possible spectrum of feeling—from full support to total opposition to the proposed rules. Though the very nature of the questions surrounding salmonid management in the Northwest and California precludes any possibility of pleasing everyone, NMFS has striven to use this public comment period—as well as every other input avenue at our disposal—to adapt the rules in a manner that more fully reflects the basic objectives to encourage state and local conservation efforts and to clear up the substantial confusions associated with certain elements of the earlier proposed rule.

Comment 292: Several commenters stated that NMFS should consult with tribal governments regarding actions by non-tribal entities, particularly those actions and limits contained in the salmon and steelhead ESA 4(d) rules.

Response: Throughout the development of the tribal and salmon/steelhead 4(d) rules NMFS has made a concerted effort to notify and confer with tribal representatives and technical staff throughout the Pacific Northwest and California. Contact regarding these rules goes back to before December of 1998, when draft rules were submitted for review by the affected tribes well in advance of the proposed rules. During that review, NMFS coordinated and attended a number of meetings and working sessions with tribal governments and representatives (including staff from inter-tribal fisheries commissions) to discuss particular aspects of the ESA 4(d) rules. These meetings allowed NMFS to develop proposed ESA 4(d) rules that the agency believes address a wide range of issues highlighted by the tribes. Similar efforts were made to discuss the proposed 4(d) rules with key staff and tribal council members after the rules were published.

Clearly, NMFS recognizes the need to work closely with the tribes of the region to develop and improve upon information exchange and consultation opportunities relating to salmon and steelhead conservation. Since beginning work on these 4(d) rules NMFS has added a tribal liaison position to its staff to focus on improving communications with the tribes and developing consultation procedures that will meet both NMFS and tribal needs. It is the agency's intent to continue working with tribal governments to develop regularly scheduled meetings between NMFS and tribal technical staff and policy makers to both provide more timely notice regarding NMFS activities and discuss how consultation might occur for future fisheries issues and ESA rulemaking. There remains the opportunity for the tribes and the agency to hold future discussions on applying the ESA 4(d) rules. Such future discussions can include identifying cultural and economic issues requiring the agency's attention and ideas about how such analyses should be conducted. In response to tribal requests, NMFS will correspond with each commenting tribal government, clarify how its comments were addressed, and identify the need for additional meetings to discuss potential rule amendments and modifications.

Comment 293: Many people stated that any activities conducted in accordance with the Oregon Plan for Salmon and Watersheds should receive a specific limitation on the take prohibitions.

Response: NMFS has carefully reviewed the various versions of the Oregon Plan since its genesis over 4 years ago and remains a strong supporter of it as a hugely ambitious and comprehensive effort. While many portions of the Plan may sufficiently protect the salmon resource as they now stand, other components need further work and refinements, as is widely understood and altogether understandable. Therefore, because certain parts of the Plan do not offer the salmon enough protection, NMFS cannot adopt it wholesale as a limitation on the take prohibitions.

Comment 294: Several commenters requested that NMFS clarify how it will add new limits and adjust programs that are already within a limit.

Response: NMFS will continue to work with local jurisdictions and other entities to develop and adopt new ESA 4(d) rule limits. In general, local entities will develop a proposed limit based on the guidance set forth in the rule and will bring it to NMFS for technical assistance and to undergo a negotiation and approval process. The approach is a flexible one and there are different time frames and administrative procedures for each limit—depending on the type being proposed (see the regulatory text of this final rule). Existing limits will be reviewed and evaluated according to the schedule established at the time the limit is finalized.

Comment 295: One commenter requested that NMFS identify in the final rules the "replicable" elements of any of the agency-specific programs.

Response: There are two types of limits available through the ESA 4(d) rule: (1) Stand alone programs, and (2) a set of criteria that will form the basis for future programs that NMFS will evaluate for further limits on the take prohibition. The first category of limits is made up of programs that can be adopted or adapted as "replicable" elements for other jurisdictions or entities. The criteria in the latter type of limit also serve as replicable elements that other programs can adapt to meet.

Comment 296: A number of respondents expressed a general concern that the ESA 4(d) rules were too coercive. They stated that the rules would engender third-party lawsuits or simply fragment and undermine local efforts rather than bolster them. A recurring theme was that NMFS should be more flexible in its approach than the rules would seem to indicate.

Response: One of the primary reasons NMFS has taken this ground-breaking approach in publishing ESA 4(d) rules is to allow for a maximum of local input and Federal flexibility. Rather than simply impose blanket take prohibitions of the sort normally promulgated under a final rule listing a species, NMFS has attempted to create a regulatory environment within which local initiatives and programs have sufficient leeway to remain focused on their own goals while simultaneously working toward the ultimate end of preserving salmonid stocks—both now and in the future. No agency can alter the simple fact that certain activities that harm listed salmonids must be regulated. Nonetheless, as the rules themselves demonstrate, NMFS is committed to an approach that focuses more on aiding local efforts that conserve listed salmon and steelhead.

Comment 297: Some commenters stated that local entities should have little or no authority to carry out the measures because local initiatives have a very poor track record with respect to protecting salmonids.

Response: The task of protecting salmonids in the Pacific Northwest and California is perhaps the most complicated and far-reaching attempt to restore a species ever undertaken. In practical terms, the Federal government alone, using only Federal authorities and dollars, cannot hope to accomplish this ambitious task of salmon recovery without the additional active efforts of state and local authorities and the private sector. A wide mosaic of activities affect salmon habitat. Those activities fall under the responsibility of a range of Federal, state and local authorities. The practical ability to make changes in those activities will depend in part upon the willingness and ability of those separate authorities to encourage change. Therefore, NMFS is attempting, to the greatest extent practicable, to build opportunities for state and local initiatives in the implementation of the ESA program. This strategy has already proven successful in a few areas where watershed councils and other local bodies have made great strides in salmon conservation through habitat rehabilitation, community awareness seminars, and other projects. NMFS anticipates and welcomes further expansions of these efforts over time.

Comment 298: Many commenters stated that individual landowners should receive assurances in the rules that if they cooperated and followed the measures outlined, they would be free from any further restrictions under the ESA.

Response: As a matter of law, listed species may not be taken without legal authorization. Therefore, it is incumbent upon every individual and organization to be vigilant in terms of minimizing the impacts their activities have on listed salmonids. The 4(d) rules establish take prohibitions; that is their purpose. Secondarily they are an attempt to allow landowners and every other interested party a path by which they can have some assurance that their activities are in concert with the letter and intent of the ESA. It should be noted that no one will be forced to seek a 4(d) limitation, and no one need necessarily follow the limitations laid out in the rule. They are optional, flexible methods for ensuring that individual entities adhere to the mandated take prohibitions. The other routes for complying with the ESA are still open; for example, landowners may still seek ESA section 10 incidental take permits through the process of developing habitat conservation plans—a process that offers them a good deal of assurance that their activities will continue to be in compliance with the ESA. Any program or activity that adheres to the criteria found in the limits described in these rules will receive a similar sort of assurance. Further, it is very likely that other programs will come forth in the future that similarly protect the salmon and, as a consequence, will receive their own limitations on the take prohibitions. Nonetheless, it must be stressed that the primary purpose of these rules is to fulfill the mandate of the ESA in issuing regulations deemed necessary and advisable to provide for the conservation of threatened species.

Comment 299: A number of commenters asserted that the original listings were in error—most the reasons given fell into two categories: either (a) the science was inaccurate, or (b) the concept of listing ESUs is faulty.

Response: Section 4(b)(1)(A) of the ESA requires that NMFS make its listing determinations solely on the basis of the best available scientific and commercial data after reviewing the status of the species and taking into account any efforts being made to protect such species. NMFS believes that information contained in the agency's status review (Myers *et al.*, 1998), together with information cited in the final rule (NMFS, 1998a), represent the best scientific information presently available for the ESUs addressed in this final rule. NMFS made every effort to conduct an exhaustive review of all available information and solicited information and opinion from all interested parties in making the listing decisions. If in the future new data become available to change these conclusions, NMFS will act accordingly.

As to the validity of listing ESUs in the first place, general issues relating to ESUs and the ESA have been discussed extensively in past **Federal Register** documents—most recently in the final rule listing 4 ESUs of chinook salmon (64 FR 14308, September 9, 1999) and they need not be reiterated at length here. Nonetheless, the utility of the ESU concept is laid out in a 1991 document in which NMFS describes how it will apply the ESA definition of "species" to Pacific salmon (56 FR 58612, November 20, 1991). Guidance on applying this policy is contained in a NOAA Technical Memorandum entitled "Definition of 'Species' Under the Endangered Species Act: Application to Pacific Salmon" (Waples, 1991) and in a recent scientific paper by Waples (1995). It should also be pointed out that the National Research Council generally endorses the concept (NRC, 1995).

Comment 300: Several commenters were concerned about the scientific standards used to justify the inclusion of the 13 limits and to judge future limits, and suggested the generation of uniform standards.

Response: NMFS evaluated the current limits based on best available science and the concepts of VSP and PFC, and will evaluate any future limit using the same and other, more site specific guidelines. Recognizing the variable nature of the geologic, hydrologic and aquatic ecosystems across all ESUs, and the consequent variability in strategies for salmon recovery, NMFS proposes an approach that allows local innovation through the development of local and regional programs that are protective of salmon and steelhead. These programs are monitored and evaluated for their effectiveness in meeting the conservation goal of the survival and recovery of the species. While NMFS offers general guidelines, the 13 limitations and new programs offer additional specificity and strategies for meeting the conservation goal.

Comment 301: Some commenters expressed the opinion that the rules are too costly and will involve too much red tape.

Response: Saving a species is neither an easy task nor a cheap one. Nonetheless, NMFS is committed to finding the most efficient and cost-effective way of preserving salmon and steelhead on the West Coast. To assist us in this, we have prepared initial regulatory flexibility analyses of the effects the rules are likely to have on small businesses, non-profit organizations, local governments, and other small entities. The purpose of these analyses is to help the agency consider all reasonable regulatory alternatives that would minimize the rules' economic impacts on affected small entities. It is thus our intent to make full use of these analyses and keep economic impacts to a minimum.

In addition, because this is a new approach to promulgating 4(d) rules under the ESA, we are aware that the process may impose some unforseen burdens in terms of time investment and paperwork for all involved parties—including NMFS. To counter this, we will use the principles of adaptive management to streamline the process wherever and whenever possible.

Comment 302: A number of people stated that more time was needed for completing and commenting on the rules.

Response: NMFS has been working with individual programs, tribes, and local governments all over the Northwest for well over 2 years to complete the 4(d) rule proposals. Twenty-five public meetings were held in order to get input. The statutory time line for commenting on the rules was doubled so that every interested person in the region would have a reasonable amount of time in which to formulate and submit their comments.

It is important to note, however, that one of the main premises of promulgating these rules is to build a maximally adaptive process for managing salmon on the West Coast. Therefore, it is expected that these rules will continue to change in response to incoming monitoring data, further public input, other proposed limitations on the take prohibitions, and the developing recovery plans for the listed species.

Comment 303: One commenter requested that the reference to a public comment period of 30 days for various plans and programs be included in every section of the rule in order to provide consistency in process between limits.

Response: All programs that are accepted as ESA 4(d) limits will be published in the **Federal Register** and the usual comment period is 30 days. NMFS makes clear in the regulatory text of this final rule where and when the 30-day comment period applies.

Comment 304: Many commenters agreed with various portions of the rules, but stated that it is imperative that they be enforced and that monitoring and oversight need to be accounted for in every limit. Further, monitoring must be built into the system in a way that allows the limits to be altered when evolving science shows it necessary.

Response: Change in response to new data is the very heart of the adaptive management process. NMFS is committed to continually bringing the best and latest information to bear on the question of how to best preserve declining salmon stocks—monitoring is a critical path for developing that information. Most of the programs given limitations in the 4(d) rules feature monitoring as an integral part. The language in the final rules has been changed slightly to further stress the importance of monitoring and to make clear that it will be used to alter the programs where necessary.

Comment 305: Some commenters suggested that the results from monitoring data for programs implemented under different limits should be available for public comment. Another commenter urged that the process for reviewing the effectiveness of the fish protection measures include tribal managers, independent scientists, and the public.

Response: The results of monitoring data from programs within ESA 4(d) limits will be available for public review at the appropriate NMFS office. At this time, however, NMFS does not have a mechanism to seek formal public comment on the data. NMFS will continue to seek monitoring data, input, and other relevant information from co-managers and others as the programs are reviewed, evaluated, and adjusted.

Comment 306: Some commenters wanted to know why NMFS believes it is necessary to have such a detailed review and reporting process for the limits when FWS does not require anything like it for wildlife.

Response: As stated previously, this is a ground-breaking approach to managing threatened species. Its intent is to allow a maximum of local input while simultaneously offering the largest possible degree of protection for the species. It has never been tried before and, as a result, it is imperative that we keep a very close eye on its progress. Aside from the need for monitoring to allow the process to adapt, these rules will eventually become part of the larger recovery planning process. By closely examining the success of the proposed measures, we can get a much better idea of what it will take to fulfill the ultimate portion of our mandate: to recover the species.

Comment 307: One commenter recommended that NMFS work with FWS to make sure that Federal activities receive take prohibition limits under our ESA 4(d) rules similar to the ones being proposed for Bull trout. In addition, another commenter urged close coordination with FWS to prevent different interpretations of take and different limits being offered.

Response: NMFS always seeks to cooperate with FWS, and procedures have been established for joint consultation on ESA rulemaking and for reviewing Federal programs through section 7 of the ESA. NMFS anticipates that this cooperation will be strengthened as the 4(d) rule is implemented. NMFS will further work with FWS to ensure that the existing bull trout take prohibitions might be modified to reflect appropriate state or local efforts in parallel to this final rule.

Comment 308: Some tribal commenters were concerned that the 4(d) rules could serve as a "back door" to unfairly allocate the conservation burden on tribal governments. The concern is that if the program is not scientifically rigorous enough, the Agency would be forced to turn to the tribes for additional conservation burden (i.e., limit fishing or development activities).

Response: NMFS intends to review all new proposed limitations rigorously for their contribution to the conservation of the species using existing criteria and additional site-specific tools. In addition, before any program is accepted, it will be published in the **Federal Register** for public review and comment. NMFS expects this process to be rigorous and open enough to permit the development of effective protective regulations and programs.

Comment 309: Some commenters stated that NMFS should delineate specific population parameters for several named populations (e.g., the Yuba River) so it can be determined if they may be excepted from having any take prohibitions placed on them. Some commenters wanted the rules to be eased when a viable population size is reached in order to give landowners an incentive to continue using protective measures.

Response: The limits on take prohibitions are given for specific activities, not for populations. If an activity helps conserve salmonids or if it adequately limits impacts on salmonids, it may receive a limitation on the take prohibitions. In the spirit of adaptive management, there may well come a point in the future where a population (and its ESU) has rebounded to the point where it is healthy enough, viable enough, that alternative management actions would be allowable. Of necessity, this would first take place in a highly controlled experimental environment that would allow researchers to determine the impacts of any new management scheme. Until that time, however, it is necessary to protect the salmonids while we get a better measure of population viability and place it firmly in the context of managing West Coast salmon. NMFS scientists are working diligently to accomplish that goal and will continue to use their results to adapt the agency's ongoing salmon management programs.

Comment 310: Some commenters stated that the overall regulatory scheme was too fragmented. They stated the need for a clear pathway for local and state governments to synthesize their programs with the ESA 4(d) approach. They also stated there should be a better recognition of the limitations local governments face in terms of staffing, funding, and ability to monitor.

Response: One of this final rule's purposes is to develop a process that is flexible, adaptable, and receptive to greater participation from local entities. In order to accomplish this, the regulatory scheme must remain somewhat open as well. Nonetheless, though NMFS desires to remain open to new approaches, we have also included a good deal of guidance as to what we believe any program should contain in terms of protective measures for salmon. Also, we will continue to do what we can to assist local entities, watershed councils, and others with instruction, technical assistance, and, whenever possible, funding.

Comment 311: Some commenters asserted that NMFS cannot anticipate how many states or local governments will be affected by the rule or how many entities or jurisdictions will apply for coverage under the new ESA 4(d) limits. Others commented that NMFS will be inundated and overwhelmed with requests for programs to come under a 4(d) limit and suggested simplified procedures streamlining the review and approval of future potential take limitations.

Response: NMFS is anticipating strong interest from state and local governments in the ESA 4(d) limits. We are encouraging jurisdictions to work together in developing plans that cover wide geographic scales and multiple activities—thus reducing the number of individual programs that need to be reviewed. Also, we anticipated that promulgating these rules would increase workloads and, as a result, we are evaluating our resource needs and are fully committed to meeting future program demands.

Comment 312: Several commenters suggested that NMFS provides no scientific basis to categorically apply the take prohibition to an entire category of activities such as agriculture, and that the agency provides no technical guidance on take avoidance.

Response: The take prohibitions do not apply to categories of activities, but to any activities that take listed species. The section on "Take Guidance" provides further information on those activities that have a high risk of take. NMFS stands ready to work with interested parties to provide further guidance, including guidance that could ultimately be included as a 4(d) limitation.

Comment 313: Several commenters were confused by multiple **Federal Register** documents and didn't realize that there were several separate ESA 4(d) rules.

Response: For the final rules, we have combined the chinook and the steelhead rules to help reduce some of the confusion. We hope this, along with several changes in the rule' language will make things a bit more clear.

Changes to the Proposed ESA 4(d) Rules

The proposed rules included a lengthy preamble where NMFS provided technical guidance, description of the scientific principles upon which the limits on the take prohibition were based, and a description of the background and content of the 13 limits. The proposed regulatory language was included in sections 223.203 and 223.208. Modifications to the proposed preamble sections based on written comments will be reflected in "A Citizen's Guide to the 4(d) Rule" (NMFS, 2000), while the actual changes to the regulatory language are described as follows.

An important change to highlight is that the final 4(d) rules for the different ESUs have different effective dates. In the final steelhead and salmon 4(d) rule the effective date for the steelhead ESUs (§ 223.102(a)(5) through (a)(9) and (a)(14) and (a)(15)) is September 8, 2000. The effective date for the salmon ESUs (§ 223.102(a)(10), (a)(12), (a)(13) and (a)(16) through (a)(19)) is January 8, 2001. NMFS recognizes that the final 4(d) rules are complex and that even the proposed rules created a certain amount of confusion among those who commented on them. The court-ordered settlement date requires NMFS to adopt protective regulations for the steelhead ESUs by June 19, 2000. NMFS, however, is not under a similar court-mandated time line for the salmon ESUs. Therefore, because of the rule's length and complexity, the diverse range of human activities that will potentially be affected, and the continued need to educate all sectors of the public, the effective date for the salmon ESUs will be six months after publication of this **Federal Register** document. This 6-month period will allow NMFS to educate and work with all jurisdictions, entities, and individuals affected by the rule. It will also provide additional time for them to review their activities and programs and adjust them (if needed) to avoid taking threatened species.

The general format of the proposed regulations included the prohibitions of section 9(a)(1) of the ESA (16 U.S.C. 1538) relating to endangered species being applied to the 14 listed threatened salmonid ESUs, except as provided in the 13 limits on application of the section 9(a)(1)(B) and 9(a)(1)(C) take prohibitions that are included in the regulation. The proposed rules listed the following 13 limit categories: (1) Activities conducted in accord with

ESA incidental take authorization; (2) ongoing scientific research activities, for a period of 6 months from the publication of the final rule; (3) emergency actions related to injured, stranded, or dead salmonids; (4) fishery management activities; (5) hatchery and genetic management programs; (6) activities in compliance with joint tribal/state plans developed within *U.S.* v. *Washington* or *U.S.* v. *Oregon*; (7) scientific research activities permitted or conducted by the states; (8) state, local, and private habitat restoration activities; (9) properly screened water diversion devices; (10) routine road maintenance activities in Oregon; (11) certain park maintenance activities in the City of Portland, Oregon; (12) certain municipal, residential, commercial and industrial (MRCI) development and redevelopment activities; and (13) forest management activities within the state of Washington.

NMFS is modifying the final ESA 4(d) protective regulations for these 14 ESUs based on comments and new information received on the proposed rules. The following section summarizes how the regulatory language for each limit and technical issues did or did not change. The actual regulatory descriptions of each limit and technical information can be found in the regulatory text at the end of this **Federal Register** document.

Viable Salmonid Populations Paper

The proposed rules solicited public comments on the draft NMFS VSP paper. The VSP paper is not a separate limit, but provides a technical framework for the fishery management and hatchery management limits. Based on public comments regarding the draft VSP paper, changes were made in the regulatory language for the fishery and hatchery management limits to clarify how the VSP data requirements will be addressed. Additional compliance guidance is available in"A Citizen's Guide to the 4(d) Rule" (NMFS, 2000).

Properly Functioning Conditions

For the reasons identified in the Comment and Responses section, language was added to the limits addressing habitat issues, i.e., habitat restoration, pest management and routine road maintenance, in order to define properly functioning condition and how NMFS will evaluate the limits with regard to meeting this biological standard.

Legal and Affirmative Defense

For the reasons identified in the Comment and Responses section, regulation language was modified to: (1) add new language to make explicit that it would be the defendant's obligation to plead and prove application of and compliance with a limit as an affirmative defense; (2) clarify the question about whether the rule should be non-severable, by making it explicit that NMFS intends the provisions of this rule to be severable.

Limit for Activities Conducted in Accord with ESA Incidental Take Authorization

No changes were made to the regulations pertaining to this limit. Additional compliance guidance is available from NMFS in "A Citizen's Guide to the 4(d) Rule" (NMFS, 2000).

Limit for Ongoing Scientific Research Activities

No changes were made to the regulations pertaining to this limit. Additional compliance guidance is available from NMFS in "A Citizen's Guide to the 4(d) Rule" (NMFS, 2000).

Limit for Rescue and Salvage Actions

No changes were made to the regulations pertaining to this limit. Additional compliance guidance is available from NMFS in "A Citizen's Guide to the 4(d) Rule" (NMFS, 2000).

Limit for Fishery Management Activities

For the reasons identified in the comment and response section, this limit was modified to: (1) change the use of a MOA between states and NMFS to a letter of concurrence from NMFS; (2) clarify the use of viable and critical salmonid population thresholds consistent with the VSP paper; (3) clarify the timing of reports describing take of listed salmonids; and (4) explain that the prohibitions on take of threatened steelhead in recreational fisheries managed solely by the states of Oregon, Washington, Idaho and California will go into effect January 8, 2001.

Limit for HGMPs

For the reasons identified in the comment and response section, this limit was modified to change the use of a MOA between states and NMFS to a letter of concurrence from NMFS.

Limit for Joint Tribal and State Plans

No changes were made to the regulations pertaining to this limit. Additional compliance guidance is available from NMFS in "A Citizen's Guide to the 4(d) Rule" (NMFS, 2000).

Limit for Scientific Research Activities Permitted or Conducted by the States

NMFS has revised the limit to reflect commenter concerns about the feasibility of adequate oversight by state fishery agencies. Additional compliance guidance is available from NMFS in "A Citizen's Guide to the 4(d) Rule" (NMFS, 2000).

Limit for Habitat Restoration

For the reasons identified in the Comment and Responses section, this limit was modified to: (1) clarify that take prohibitions do not apply to habitat restoration activities provided the activity is part of a WCP that meets criteria listed in the regulation; (2) change the time frame to complete a watershed conservation plan from 2 years to an undetermined time, so that the limit is available whenever the criteria described in the regulation are met; (3) delete the list of six categories of habitat restoration activities that would not have the ESA section 9 take prohibitions applied to them for 2 years; (4) clarify and revise the criteria NMFS will use to evaluate a state's watershed conservation plan guidelines; and (5) clarify that NMFS will not approve individual WCPs; instead, NMFS will approve the WCP guidelines with each state and periodically review the state watershed planning programs for consistency with the guidelines. Additional compliance guidance is available from NMFS in "A Citizen's Guide to the 4(d) Rule" (NMFS, 2000).

Limit for Water Diversion Screening

For the reasons identified in the comment and response section, this limit was modified to: (1) allow NMFS-authorized state agency engineers ("authorized officers") to review and recommend certification of screen designs to NMFS rather than NMFS' engineers solely having this responsibility; and (2) allow NMFS, on a case by case basis, to grant this limit to water diversion projects where NMFS has approved a design construction plan and schedule, including interim operation measures to reduce the likelihood of take. NMFS may also require a commitment of compensatory mitigation if implementation of a plan and schedule is terminated prior to completion.

Limit for Routine Road Maintenance Activities

For the reasons identified in the comment and response section, this limit was modified to: (1) allow this limit to be available to any state, county, city, or port once they have demonstrated in writing that their routine road maintenance activities are equivalent to those in the ODOT Guide which adequately protect threatened salmonid species; or by employees or agents of a state, county, city or port that complies with a routine road maintenance program that meets proper functioning habitat conditions; (2) add language referring to state, city, county, and ports; (3) change the time frame for ODOT or another jurisdiction to respond to new information in the shortest amount of time feasible, but not longer than one year; (4) clarify that prior to approving any state, city, county, or port program as within this limit, or approving any substantive change in a program within this limit, NMFS will publish notification in the **Federal Register**; (5) clarify that any jurisdiction should first commit in writing to apply the management practices in the ODOT Guide, rather than the proposed language, which first required the jurisdiction to enter into a memorandum of agreement with NMFS; and (6) add new language regarding properly functioning condition. Additional compliance guidance is available from NMFS in "A Citizen's Guide to the 4(d) Rule" (NMFS, 2000).

Limit for Certain Integrated Pesticide Management Activities

For the reasons identified in the Comment and Responses section, this limit was modified to: (1) add new language regarding properly functioning conditions; and (2) clarify language regarding how NMFS will address future program changes and provide public notice that the limit is withdrawn. Additional compliance guidance is available from NMFS in "A Citizen's Guide to the 4(d) Rule" (NMFS, 2000).

Limit for Municipal, Residential, Commercial and Industrial (MRCI) Development and Redevelopment Activities

For the reasons identified in the Comment and Responses section, this limit was modified to: (1) clarify that this limit applies to MRCI development and redevelopment undertaken by cities, counties, and regional governmental entities; (2) expand and clarify the content of the 12 evaluation considerations NMFS will use to review MRCI development ordinances and plans; (3) add new language to emphasize the properly functioning habitat conditions NMFS considers adequate to conserve listed salmonids; (4) clarify that NMFS notes that not all 12 considerations described in the regulation will necessarily be relevant to all ordinances and plans submitted for review and approval; and (5) include language which clarifies the process NMFS will use to provide notice of availability of ordinances and plans for public review, and NMFS' process to amend or withdraw limits.

Limit for Forest Management Activities in the State of Washington

For the reasons identified in the Comment and Responses section, this limit was modified to add new language stating that actions taken under alternative plans are included in this limit provided that they meet the requirements stated in the regulation and are submitted and approved by the authorized Washington state agency.

Take Guidance

These threatened species are in danger of becoming extinct in the foreseeable future. They have been depleted by over-fishing, past and ongoing freshwater and estuarine habitat destruction, hydropower development, hatchery practices, and other causes. It is, therefore, necessary and advisable to put into place ESA section 9(a)(1) prohibitions to aid in their conservation. Section 9(a)(1) prohibitions make it illegal for any person subject to the United States' jurisdiction to "take" these species without written authorization ("take" is defined to occur when a person engages in activities that harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect a species or attempt to do any of these). Impacts on a protected species' habitat may harm members of that species and, therefore, constitute a "take" under the ESA. Such an act may include significant habitat modification or degradation that actually kills or injures listed fish by significantly impairing essential behavioral patterns including breeding, spawning, rearing, migrating, feeding, or sheltering.

On July 1, 1994 (59 FR 34272), NMFS and FWS published a policy committing both agencies to identify, to the extent possible, those activities that would or would not violate section 9 of the ESA. The intent of this policy is to increase public awareness about ESA compliance and focus public attention on those actions needed to protect species.

Based on available information, NMFS believes the categories of activities listed here are those activities which as a general rule may be most likely to result in injury or harm to listed salmonids. NMFS wishes to emphasize at the outset that whether injury or harm is resulting from a particular activity is entirely dependent upon the facts and circumstances of each case. The mere fact that an activity may fall within one of these categories does not at all mean that that specific activity is causing harm or injury. These types of activities are, however, those that may be most likely to cause harm and thus violate this rule. NMFS' ESA enforcement will therefore focus on these categories of activities.

Activities listed in A thru J below are as cited in NMFS' harm rule 64 FR 215 (November 8, 1999).

A. Constructing or maintaining barriers that eliminate or impede a listed species' access to habitat or ability to migrate.

B. Discharging pollutants, such as oil, toxic chemicals, radioactivity, carcinogens, mutagens, teratogens or organic nutrient-laden water including sewage water into a listed species' habitat.

C. Removing, poisoning, or contaminating plants, fish, wildlife, or other biota required by the listed species for feeding, sheltering, or other essential behavioral patterns.

D. Removing or altering rocks, soil, gravel, vegetation or other physical structures that are essential to the integrity and function of a listed species' habitat.

E. Removing water or otherwise altering streamflow when it significantly impairs spawning, migration, feeding or other essential behavioral patterns.

F. Releasing non-indigenous or artificially propagated species into a listed species' habitat or where they may access the habitat of listed species.

G. Constructing or operating dams or water diversion structures with inadequate fish screens or fish passage facilities in a listed species' habitat.

H. Constructing, maintaining, or using inadequate bridges, roads, or trails on stream banks or unstable hill slopes adjacent to or above a listed species' habitat.

I. Conducting timber harvest, grazing, mining, earth-moving, or other operations which result in substantially increased sediment input into streams.

J. Conducting land-use activities in riparian areas and areas susceptible to mass wasting and surface erosion, which may disturb soil and increase sediment delivered to streams, such as logging, grazing, farming, and road construction.

K. Illegal fishing. Harvest in violation of fishing regulations will be a top enforcement concern.

L. Various streambed disturbances may trample eggs or trap adult fish preparing to spawn. The disturbance could be mechanical disruption caused by constructing push-up dams, removing gravel, mining, or other work in a stream channel. It may also take the form of egg trampling or smothering by livestock in the streambed or by vehicles or equipment being driven across or down the streambed (as well as any similar physical disruptions).

M. Interstate and foreign commerce dealing in listed salmonids and importing or exporting listed salmonids may harm the fish unless it can be shown—through an ESA permit—that they were harvested in a manner that complies with ESA requirements.

N. Altering lands or waters in a manner that promotes unusual concentrations of predators.

O. Shoreline and riparian disturbances (whether in the riverine, estuarine, marine, or floodplain environment) may retard or prevent the development of certain habitat characteristics upon which the fish depend (e.g., removing riparian trees reduces vital shade and cover, floodplain gravel mining, development, and armoring shorelines reduces the input of critical spawning substrates, and bulkhead construction can eliminate shallow water rearing areas).

P. Filling or isolating side channels, ponds, and intermittent waters (e.g., installing tide gates and impassable culverts) can destroy habitats that the fish depend upon for refuge areas during high flows.

The list provides examples of the types of activities that could have a high risk of resulting in take but it is by no means exhaustive. It is intended to help people avoid violating the ESA and to encourage efforts to save the species. Determination of whether take has actually occurred depends on the circumstances of a particular case.

Many activities that may kill or injure salmonids are regulated by state and/or Federal processes, such as fill and removal authorities, NPDES or other water quality permitting, pesticide use, and the like. For those types of activities, NMFS would not intend to concentrate enforcement efforts on those who operate in conformity with current permits. Rather, if the regulatory program does not provide adequate salmonid protection, NMFS intends to work with the responsible agency to make necessary changes in the program.

For instance, concentrations of pesticides may affect salmonid behavior and reproductive success. Current EPA label requirements were developed in the absence of information about some of these subtle but real impacts on aquatic species such as salmonids. Where new information indicates that label requirements are not adequately protective of salmonids, NMFS will work with EPA through the section 7 consultation process to develop more protective use restrictions, and thereby provide the best possible guidance to all users. Similarly, where water quality standards or state authorizations lead to pollution loads that may cause take, NMFS intends to work with the state water quality agencies and EPA to bring those standards or permitting programs to a point that does protect salmonids.

Persons or entities who conclude that their activity is likely to injure or kill protected fish are encouraged to immediately adjust that activity to avoid take (or adequately limit any impacts on the species) and seek NMFS' authorization for incidental take under (a) an ESA section 10 incidental take permit; (b) an ESA section 7 consultation; or (c) a limit on the take prohibitions provided in this rule. The public is encouraged to contact NMFS (see **FOR FURTHER INFORMATION CONTACT**) for assistance in determining whether circumstances at a particular location (involving these activities or any others) constitute a violation of this rule.

State and local efforts like the Oregon Plan for Salmon and Watersheds, the State of Washington's Extinction is Not an Option Plan, Metro's Functional Plan, the Puget Sound Tri-County Initiative and Lower Columbia Fish Recovery Board in Washington state, the Eugene, Oregon-area Metro ESA Coordinating Team, and the Willamette Restoration Initiative (WRI) have stepped forward and assumed leadership roles in saving these species. NMFS reiterates its support for these efforts and encourages them to resolve critical uncertainties and further develop their programs so they can take the place of blanket ESA take prohibitions.

Impacts on listed salmonids resulting from actions in compliance with a permit issued by NMFS pursuant to section 10 of the ESA are not violations of this rule. Section 10 permits may be issued for research activities, enhancement of a species' survival, or to authorize incidental take occurring in the course of an otherwise lawful activity. NMFS consults on a broad range of activities conducted, funded, or authorized by Federal agencies. These include fisheries harvest, hatchery operations, silviculture activities, grazing, mining, road construction, dam construction and operation, discharge of fill material, and stream channelization and diversion. Federally-funded or approved activities that affect listed salmonids and for which ESA section 7 consultations have been completed and any take authorized, will not constitute violations of this rule—provided the activities are conducted in accord with all reasonable and prudent measures, terms, and conditions stated in the consultation and incidental take permit.

References

A list of references cited in this final rule is available upon request (see **ADDRESSES**).

Classification

Regulatory Flexibility Act

The Regulatory Flexibility Act (RFA) (5 U.S.C. 601–612) was designed to ensure that agencies carefully assess whether aspects of a proposed regulatory scheme (record keeping, safety requirements, etc.) can be tailored to be less burdensome for small businesses while still achieving the agency's statutory responsibilities. NMFS prepared an initial regulatory flexibility analysis (IRFA) which was made available through the proposed rule. Several public comments were received related to the IRFA or to economic impacts generally. Those comments and NMFS responses to them are summarized in the Response to Comments section. NMFS has prepared a Regulatory Impact Review (RIR) and a Final Regulatory Flexibility Analysis (FRFA), taking into consideration the public comments received. A summary of the final FRFA follows. The FRFA is available upon request (see **ADDRESSES**), or may be accessed on NMFS web site at www.nwr.noaa.gov.

This ESA 4(d) rule has no specific requirements for regulatory compliance; it essentially sets an enforceable performance standard (do not take listed fish) that applies to all entities and individuals within the ESU unless that activity is within a carefully circumscribed set of activities on which NMFS will not impose the take prohibitions. Hence, the universe of entities reasonably expected to be directly or indirectly impacted by the prohibition is broad.

The geographic range of these regulations crosses four states and the number of entities potentially affected by imposition of take prohibitions is substantial. Activities potentially affecting salmonids are those associated with agriculture, forestry, fishing, mining, heavy construction, highway and street construction, logging, wood and paper mills, electric services, water transportation, tourism, real estate, and other industries. As many of these activities involve local, state, and Federal oversight, including permitting, governmental activities from the smallest towns or planning units to the largest cities will also be impacted. The activities of some nonprofit organizations will also be affected by these regulations.

NMFS examined in as much detail as practical the potential impact of the regulation on a sector by sector basis. Unavailable or inadequate data leaves a high degree of uncertainty surrounding both the numbers of entities likely to be affected, and the characteristics of any impacts on particular entities. The problem is complicated by differences among entities even in the same sector as to the nature and size of their current operations, proximity to waterways, the degree to which the operation is already protective of salmonids, and individual strategies for dealing with the take prohibitions.

There are no recordkeeping or reporting requirements associated with the take prohibition and, therefore, it is not possible to simplify or tailor recordkeeping or reporting to be less burdensome for small entities. Some limits, for which NMFS has found it not necessary to prohibit take, involve recordkeeping and/or reporting to support that continuing determination. NMFS has attempted to minimize any burden associated with programs for which the take prohibitions are not enacted. The final rule does not duplicate, overlap, or conflict with any other relevant Federal rules.

In formulating this rule, NMFS considered several alternative approaches, described in more detail in the FRFA. These included:

(1) Enacting a "global" protective regulation for threatened species, through which section 9 take prohibitions are applied automatically to all threatened species at the time of listing; (2) ESA 4(d) protective regulations with no limits, or only a few limits, on the application of the take prohibition for relatively uncontroversial activities such as fish rescue/salvage; (3) take prohibitions in combination with detailed prescriptive requirements applicable to one or more sectors of activity; (4) ESA 4(d) protective regulations similar to the existing interim 4(d) protective regulations for Southern Oregon/ Northern California coast coho, which includes four limits on the take prohibition for harvest plans, hatchery plans, scientific research, and habitat restoration projects, when in conformance with specified criteria; (5) a protective regulation similar to the interim rule, but with recognition of more programs and circumstances in which application of take prohibitions is not necessary and advisable; (6) an option earlier advocated by the State of Oregon and others, in which ESA section 9 take prohibitions would not be applied to any activity addressed by the Oregon Plan for Salmon and Watersheds, fundamentally deferring protections to the state; and (7) enacting no protective regulations for threatened steelhead. The first four alternatives would place greater burdens on small entities. Alternative 6 would not provide sufficient protections (see response to comments), while alternative 7 would leave the ESUs without any protection other than provided by ESA section 7 consultations for actions with some Federal nexus. NMFS could not support that approach as being consistent with the obligation to enact such protective regulations as are "necessary and advisable to provide for the conservation of" the listed steelhead. Alterative 5 is the approach taken in this rule.

As a result of comments received related to the proposed rules and IRFAs, NMFS has modified the regulations to broaden the applicability of some limits, and to make them more flexible. For instance, the road maintenance limit is now generally available. The limit for development has been broadened to cover a greater range of types of plans or ordinances, and has been modified to allow for circumstances where a jurisdiction's ordinances may not address all of the evaluation criteria, but nonetheless are adequate for a limit for those aspects addressed. These types of adjustments provide additional options for jurisdictions that may wish to seek ESA compliance assurances.

NMFS concludes that at the present time there are no legally viable alternatives to the final rule, as modified from the proposals, that would have less impact on small entities and still fulfill the agency's obligations to protect listed salmonids. The first four alternatives may result in unnecessary impacts on economic activity of small entities, given NMFS' judgment that more limited protections would suffice to conserve the species.

Executive Order 12866

Under E.O. 12866 (58 FR 51735, October 4, 1993), NMFS has prepared a Regulatory Impact Review (RIR) which considers costs and benefits of available regulatory alternatives, including the alternative of not regulating. Costs and benefits include both quantifiable measures (to the fullest extent that these can be usefully estimated) and qualitative measures of costs and benefits where estimates cannot be meaningfully made for impacts that are essential to consider. We cannot quantify the economic effect of this rule, given the geographic scope and the size and economic dimensions of the potentially affected economic sectors that operate within the ESUs, but have considered costs and benefits qualitatively in structuring the rule. Although only a share of the benefits from the recovery of threatened salmonids to a sustainable level would be attributable to this rule, it is clear that the potential costs associated with imposing take prohibitions to protect those salmonids are associated with substantial potential tangible and intangible returns.

The ESA limits NMFS to alternatives that lead to recovery, but in choosing among alternatives, we are obligated to consider taking the least cost path. NMFS has concluded that among the alternative regulatory approaches, the approach in this final rule (with changes made in response to public comment) will maximize net benefits (including potential economic, environmental, public health and safety, and other advantages, distributive impacts; and equity) and minimize costs, within the constraints of the ESA. Because this alternative exempts activities that fall within adequate state or local programs, NMFS' involvement will be more collaborative and less often require enforcement actions. This alternative has the greatest probability that compliance burdens will be equally shared, that economic incentives will be employed in appropriate cases, and that practical standards adapted to the particular characteristics of a state or region will aid citizens in reducing the risks of take in an efficient way. For these reasons, it is likely that this alternative will minimize the financial burden on the public of avoiding take over the long term.

Executive Order 13084 Consultation and Coordination with Indian Tribal Governments

E.O. 13084 requires that if NMFS issues a regulation that significantly or uniquely affects the communities of Indian tribal governments and imposes substantial direct compliance costs on those communities, NMFS must consult with those governments or the Federal government must provide the funds necessary to pay the direct compliance costs incurred by the tribal governments. This rule does not impose substantial direct compliance costs on the communities of Indian tribal governments. Accordingly, the requirements of section 3(b) of E.O. 13084 do not apply to this final rule.

Nonetheless, NMFS took several steps to inform tribal governments and solicit their input during development of the proposed rule, and made numerous adjustments to the proposal as a result of those contacts. A number of Indian tribal governments, as well as both the Columbia River Intertribal and Northwest Indian Fisheries

Commissions, commented formally on the proposed rules. In addition, NMFS has continued both informal exchanges with tribal representatives and meetings with tribal officials. These exchanges have resulted in some refinements of the rule, as well as greater appreciation by NMFS of the challenges ahead as it implements the rule. NMFS has proposed an ongoing, regular meeting schedule to assure continued exchange of information with the numerous tribal governments on matters of interest, including matters associated with this rule.

Executive Order 13132—Federalism

E.O. 13132 requires agencies to take into account any federalism impacts of regulations under development. It includes specific consultation directives for situations where a regulation will preempt state law, or impose substantial direct compliance costs on state and local governments (unless required by statute). Neither of those circumstances is applicable to this rule. In fact, this rule provides a route by which NMFS may defer to state and local government programs, where they provide necessary protections for threatened salmonids.

Although not required by E.O. 13132, in keeping with the intent of the Administration and Congress to provide continuing and meaningful dialogue on issues of mutual state and Federal interest, NMFS conferred with numerous state, local and other governmental entities while preparing the proposed rules, and has had continued informal and formal contacts with all affected states. We have held workshops explaining the rule to interested local or regional entities and exploring possible implementation strategies as well as options for future limits with those attending.

In addition to these efforts, NMFS staff have given numerous presentations to interagency forums, community groups, and others, and served on a number of interagency advisory groups or task forces considering conservation measures. Many cities, counties and other local governments have sought guidance and consideration of their planning efforts from NMFS, and NMFS staff have met with them as rapidly as our resources permit. Finally, NMFS' Sustainable Fisheries Division staff have continued close coordination with state fisheries agencies toward development of artificial propagation and harvest plans and programs that will be protective of listed salmonids and ultimately may be recognized within this rule. NMFS expects to continue to work with all of these entities in implementing this rule.

Paperwork Reduction Act

Notwithstanding any other provision of the law, no person is required to respond to, nor shall any person be subject to a penalty for failure to comply with, a collection of information subject to the requirements of the PRA, unless that collection of information displays a currently valid OMB Control Number.

This rule contains collection-of-information requirements subject to the Paperwork Reduction Act (PRA) and which have been approved by OMB under control number 0648-0399. Public reporting burden per response for this collection of information is estimated to average 5 hours for a submission on diversion screenings or for a report on salmonids assisted, disposed of, or salvaged; 20 hours to prepare a road maintenance agreement; 30 hours for an urban ordinance development package; and 10 hours for an urban development annual report. These estimates include the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding these burden estimates, or any other aspect of this data collection, including suggestions for reducing the burden, to NMFS (see **ADDRESSES**) and to OMB at the Office of Information and Regulatory Affairs, Office of Management and Budget, Washington, DC. 20503 (Attention: NOAA Desk Officer).

National Environmental Policy Act

NMFS prepared an Environmental Assessment (EA), as defined under the authority of the National Environmental Policy Act (NEPA) of 1969, in connection with this regulation. Based on review and evaluation of the information contained in the EA, we determined that the proposed action to promulgate protective regulations for 14 threatened salmonid ESUs, and to create limits on the applicability of the prohibition on taking any of those salmonids would not be a major Federal action that would significantly affect the quality of the human environment within the meaning of section 102(2)(c) of NEPA of 1969. NMFS received a number of comments related to NEPA compliance, which are summarized together with responses elsewhere in this notice. NMFS believes the EA examined appropriate alternatives, and that preparation of an EIS is not required. Accordingly, we adhere to our prior Finding of No Significant Impact (FONSI) for this action. The EA and FONSI are available (see **ADDRESSES**).

List of Subjects in 50 CFR Part 223

Endangered and threatened species, Exports, Imports, Marine mammals, Transportation,

Dated: June 19, 2000.

Andrew A. Rosenberg,

Deputy Assistant Administrator for Fisheries, National Marine Fisheries Service.

For reasons set out in the preamble, 50 CFR part 223 is amended as follows:

PART 223—THREATENED MARINE AND ANADROMOUS SPECIES

1. The authority citation for part 223 is revised to read as follows:

Authority: 16 U.S.C. 1531-1543; subpart B, § 223.12 also issued under 16 U.S.C. 1361 *et seq.*

2. Section 223.203 is revised to read as follows:

§ 223.203 Anadromous fish.

(a) *Prohibitions.* The prohibitions of section 9(a)(1) of the ESA (16 U.S.C. 1538(a)(1)) relating to endangered species apply to the threatened species of salmonids listed in § 223.102(a)(1) through (a)(10), and (a)(12) through (a)(19), except as provided in paragraph (b) of this section and § 223.209(a).

(b) *Limits on the prohibitions.* (1) The exceptions of section 10 of the ESA (16 U.S.C. 1539) and other exceptions under the Act relating to endangered species, including regulations in part 222 of this chapter II implementing such exceptions, also apply to the threatened species of salmonids listed in § 223.102(a)(1) through (a)(10), and (a)(12) through (a)(19).

(2) The prohibitions of paragraph (a) of this section relating to threatened species of salmonids listed in § 223.102 (a)(5) through (a)(10), and (a)(12) through (a)(19) do not apply to activities specified in an application for a permit for scientific purposes or to enhance the conservation or survival of the species, provided that the application has been received by the Assistant Administrator for Fisheries, NOAA (AA), no later than October 10, 2000. The prohibitions of paragraph (a) of this section apply to these activities upon the AA's rejection of the application as insufficient, upon issuance or denial of a permit, or March 7, 2001, whichever occurs earliest.

(3) The prohibitions of paragraph (a) of this section relating to threatened species of salmonids listed in § 223.102 (a)(4) through (a)(10), and (a)(12) through (a)(19) do not apply to any employee or designee of NMFS, the United States Fish and Wildlife Service, any Federal land management agency, the Idaho Department of Fish and Game (IDFG), Washington Department of Fish

and Wildlife (WDFW), the Oregon Department of Fish and Wildlife (ODFW), California Department of Fish and Game (CDFG), or of any other governmental entity that has co-management authority for the listed salmonids, when the employee or designee, acting in the course of his or her official duties, takes a threatened salmonid without a permit if such action is necessary to:

(i) Aid a sick, injured, or stranded salmonid,

(ii) Dispose of a dead salmonid, or

(iii) Salvage a dead salmonid which may be useful for scientific study.

(iv) Each agency acting under this limit on the take prohibitions of paragraph (a) of this section is to report to NMFS the numbers of fish handled and their status, on an annual basis. A designee of the listed entities is any individual the Federal or state fishery agency or other co-manager has authorized in writing to perform the listed functions.

(4) The prohibitions of paragraph (a) of this section relating to threatened species of salmonids listed in § 223.102 (a)(5) through (a)(10), and (a)(12) through (a)(19) do not apply to fishery harvest activities provided that:

(i) Fisheries are managed in accordance with a NMFS-approved Fishery Management and Evaluation Plan (FMEP) and implemented in accordance with a letter of concurrence from NMFS. NMFS will approve an FMEP only if it clearly defines its intended scope and area of impact and sets forth the management objectives and performance indicators for the plan. The plan must adequately address the following criteria:

(A) Define populations within affected listed ESUs, taking into account spatial and temporal distribution, genetic and phenotypic diversity, and other appropriate identifiably unique biological and life history traits. Populations may be aggregated for management purposes when dictated by information scarcity, if consistent with survival and recovery of the listed ESU. In identifying management units, the plan shall describe the reasons for using such units in lieu of population units, describe how the management units are defined, given biological and life history traits, so as to maximize consideration of the important biological diversity contained within the listed ESU, respond to the scale and complexity of the ESU, and help ensure consistent treatment of listed salmonids across a diverse geographic and jurisdictional range.

(B) Utilize the concepts of "viable" and "critical" salmonid population thresholds, consistent with the concepts contained in the technical document entitled "Viable Salmonid Populations (NMFS, 2000b)." The VSP paper provides a framework for identifying the biological requirements of listed salmonids, assessing the effects of management and conservation actions, and ensuring that such actions provide for the survival and recovery of listed species. Proposed management actions must recognize the significant differences in risk associated with viable and critical population threshold states and respond accordingly to minimize the long-term risks to population persistence. Harvest actions impacting populations that are functioning at or above the viable threshold must be designed to maintain the population or management unit at or above that level. For populations shown with a high degree of confidence to be above critical levels but not yet at viable levels, harvest management must not appreciably slow the population's achievement of viable function. Harvest actions impacting populations that are functioning at or below critical threshold must not be allowed to appreciably increase genetic and demographic risks facing the population and must be designed to permit the population's achievement of viable function, unless the plan demonstrates that the likelihood of survival and recovery of the entire ESU in the wild would not be appreciably reduced by greater risks to that individual population.

(C) Set escapement objectives or maximum exploitation rates for each management unit or population based on its status and on a harvest program that assures that those rates or objectives are not exceeded. Maximum exploitation rates must not appreciably reduce the likelihood of survival and recovery of the ESU. Management of fisheries where artificially propagated fish predominate must not compromise the management objectives for commingled naturally spawned populations.

(D) Display a biologically based rationale demonstrating that the harvest management strategy will not appreciably reduce the likelihood of survival and recovery of the ESU in the wild, over the entire period of time the proposed harvest management strategy affects the population, including effects reasonably certain to occur after the proposed actions cease.

(E) Include effective monitoring and evaluation programs to assess compliance, effectiveness, and parameter validation. At a minimum, harvest monitoring programs must collect catch and effort data, information on escapements, and information on biological characteristics, such as age, fecundity, size and sex data, and migration timing.

(F) Provide for evaluating monitoring data and making any revisions of assumptions, management strategies, or objectives that data show are needed.

(G) Provide for effective enforcement and education. Coordination among involved jurisdictions is an important element in ensuring regulatory effectiveness and coverage.

(H) Include restrictions on resident and anadromous species fisheries that minimize any take of listed species, including time, size, gear, and area restrictions.

(I) Be consistent with plans and conditions established within any Federal court proceeding with continuing jurisdiction over tribal harvest allocations.

(ii) The state monitors the amount of take of listed salmonids occurring in its fisheries and provides to NMFS on a regular basis, as defined in NMFS' letter of concurrence for the FMEP, a report summarizing this information, as well as the implementation and effectiveness of the FMEP. The state shall provide NMFS with access to all data and reports prepared concerning the implementation and effectiveness of the FMEP.

(iii) The state confers with NMFS on its fishing regulation changes affecting listed ESUs to ensure consistency with the approved FMEP. Prior to approving a new or amended FMEP, NMFS will publish notification in the **Federal Register** announcing its availability for public review and comment. Such an announcement will provide for a comment period on the draft FMEP of not less than 30 days.

(iv) NMFS provides written concurrence of the FMEP which specifies the implementation and reporting requirements. NMFS' approval of a plan shall be a written approval by NMFS Southwest or Northwest Regional Administrator, as appropriate. On a regular basis, NMFS will evaluate the effectiveness of the program in protecting and achieving a level of salmonid productivity commensurate with conservation of the listed salmonids. If it is not, NMFS will identify ways in which the program needs to be altered or strengthened. If the responsible agency does not make changes to respond adequately to the new information, NMFS will publish notification in the **Federal Register** announcing its intention to withdraw the limit for activities associated with that FMEP. Such an announcement will provide for a comment period of not less than 30 days, after which NMFS will make a final determination whether to withdraw the limit so that the prohibitions would then apply to those fishery harvest activities. A template for developing FMEPs is available from NMFS Northwest Region's website (www.nwr.noaa.gov).

(v) The prohibitions of paragraph (a) of this section relating to threatened species of steelhead listed in § 223.102 (a)(5) through (a)(9), (a)(14), and (a)(15) do not apply to fisheries managed solely by the states of Oregon, Washington, Idaho, and California until January 8, 2001.

(5) The prohibitions of paragraph (a) of this section relating to threatened species of salmonids listed in § 223.102 (a)(5) through (a)(10), and (a)(12) through (a)(19) do not apply to activity associated with artificial propagation programs provided that:

(i) A state or Federal Hatchery and Genetics Management Plan (HGMP) has been approved by NMFS as meeting the following criteria:

(A) The HGMP has clearly stated goals, performance objectives, and performance indicators that indicate the purpose of the program, its intended results, and measurements of its performance in meeting those results. Goals shall address whether the program is intended to meet conservation objectives, contribute to the ultimate sustainability of natural spawning populations, and/or intended to augment tribal, recreational, or commercial fisheries. Objectives should enumerate the results desired from the program that will be used to measure the program's success or failure.

(B) The HGMP utilizes the concepts of viable and critical salmonid population threshold, consistent with the concepts contained in the technical document entitled "Viable Salmonid Populations" (NMFS, 2000b). Listed salmonids may be purposefully taken for broodstock purposes only if the donor population is currently at or above the viable threshold and the collection will not impair its function; if the donor population is not currently viable but the sole objective of the current collection program is to enhance the propagation or survival of the listed ESU; or if the donor population is shown with a high degree of confidence to be above critical threshold although not yet functioning at viable levels, and the collection will not appreciably slow the attainment of viable status for that population.

(C) Taking into account health, abundances, and trends in the donor population, broodstock collection programs reflect appropriate priorities. The primary purpose of broodstock collection programs of listed species is to reestablish indigenous salmonid populations for conservation purposes. Such programs include restoration of similar, at-risk populations within the same ESU, and reintroduction of at-risk populations to underseeded habitat. After the species' conservation needs are met and when consistent with survival and recovery of the ESU, broodstock collection programs may be authorized by NMFS such for secondary purposes, as to sustain tribal, recreational, and commercial fisheries.

(D) The HGMP includes protocols to address fish health, broodstock collection, broodstock spawning, rearing and release of juveniles, deposition of hatchery adults, and catastrophic risk management.

(E) The HGMP evaluates, minimizes, and accounts for the propagation program's genetic and ecological effects on natural populations, including disease transfer, competition, predation, and genetic introgression caused by the straying of hatchery fish.

(F) The HGMP describes interrelationships and interdependencies with fisheries management. The combination of artificial propagation programs and harvest management must be designed to provide as many benefits and as few biological risks as possible for the listed species. For programs whose purpose is to sustain fisheries, HGMPs must not compromise the ability of FMEPs or other management plans to conserve listed salmonids.

(G) Adequate artificial propagation facilities exist to properly rear progeny of naturally spawned broodstock, to maintain population health and diversity, and to avoid hatchery-influenced selection or domestication.

(H) Adequate monitoring and evaluation exist to detect and evaluate the success of the hatchery program and any risks potentially impairing the recovery of the listed ESU.

(I) The HGMP provides for evaluating monitoring data and making any revisions of assumptions, management strategies, or objectives that data show are needed;

(J) NMFS provides written concurrence of the HGMP which specifies the implementation and reporting requirements. For Federally operated or funded hatcheries, the ESA section 7 consultation will achieve this purpose.

(K) The HGMP is consistent with plans and conditions set within any Federal court proceeding with continuing jurisdiction over tribal harvest allocations.

(ii) The state monitors the amount of take of listed salmonids occurring in its hatchery program and provides to NMFS on a regular basis a report summarizing this information, and the implementation and effectiveness of the HGMP as defined in NMFS' letter of concurrence. The state shall provide NMFS with access to all data and reports prepared concerning the implementation and effectiveness of the HGMP.

(iii) The state confers with NMFS on a regular basis regarding intended collections of listed broodstock to ensure congruity with the approved HGMP.

(iv) Prior to final approval of an HGMP, NMFS will publish notification in the **Federal Register** announcing its availability for public review and comment for a period of at least 30 days.

(v) NMFS' approval of a plan shall be a written approval by NMFS Southwest or Northwest Regional Administrator, as appropriate.

(vi) On a regular basis, NMFS will evaluate the effectiveness of the HGMP in protecting and achieving a level of salmonid productivity commensurate with the conservation of the listed salmonids. If the HGMP is not effective, the NMFS will identify to the jurisdiction ways in which the program needs to be altered or strengthened. If the responsible agency does not make changes to respond adequately to the new information, NMFS will publish notification in the **Federal Register** announcing its intention to withdraw the limit on activities associated with that program. Such an announcement will provide for a comment period of no less than 30 days, after which NMFS will make a final determination whether to withdraw the limit so that take prohibitions, likeall other activity not within a limit, would then apply to that program. A template for developing HGMPs is available from NMFS Northwest Region's website (www.nwr.noaa.gov).

(6) The prohibitions of paragraph (a) of this section relating to threatened species of salmonids listed in § 223.102 (a)(7), (a)(8), (a)(10), and (a)(12) through (a)(19) do not apply to actions undertaken in compliance with a resource management plan developed jointly by the States of Washington, Oregon and/or Idaho and the Tribes (joint plan) within the continuing jurisdiction of *United States* v. *Washington* or *United States* v. *Oregon*, the on-going Federal court proceedings to enforce and implement reserved treaty fishing rights, provided that:

(i) The Secretary has determined pursuant to 50 CFR 223.209 and the government-to-government processes therein that implementing and enforcing the joint tribal/state plan will not appreciably reduce the likelihood of survival and recovery of affected threatened ESUs.

(ii) The joint plan will be implemented and enforced within the parameters set forth in *United States* v. *Washington* or *United States* v. *Oregon*.

(iii) In making that determination for a joint plan, the Secretary has taken comment on how any fishery management plan addresses the criteria in § 223.203(b)(4), or on how any hatchery and genetic management plan addresses the criteria in § 223.203(b)(5).

(iv) The Secretary shall publish notice in the **Federal Register** of any determination whether or not a joint plan, will appreciably reduce the likelihood of survival and recovery of affected threatened ESUs, together with a discussion of the biological analysis underlying that determination.

(v) On a regular basis, NMFS will evaluate the effectiveness of the joint plan in protecting and achieving a level of salmonid productivity commensurate with conservation of the listed salmonids. If the plan is not effective, then NMFS will identify to the jurisdiction ways in which the joint plan needs to be altered or strengthened. If the responsible agency does not make changes to respond adequately to the new information, NMFS will publish notification in the **Federal Register** announcing its intention to withdraw the limit on activities associated with that joint plan. Such an announcement will provide for a comment period of no less than 30 days, after which NMFS will make a final determination whether to withdraw the limit so that take prohibitions would then apply to that joint plan as to all other activity not within a limit.

(7) The prohibitions of paragraph (a) of this section relating to threatened species of salmonids listed in § 223.102(a)(5) through (a)(10), and (a)(12) through (a)(19) do not apply to scientific research activities provided that:

(i) Scientific research activities involving purposeful take is conducted by employees or contractors of the ODFW, WDFW (Agencies), IDFG, or CDFG (Agencies), or as a part of a monitoring and research program overseen by or coordinated with that Agency.

(ii) The Agencies provide for NMFS' review and approval a list of all scientific research activities involving direct take planned for the coming year, including an estimate of the total direct take that is anticipated, a description of the study design, including a justification for taking the species and a description of the techniques to be used, and a point of contact.

(iii) The Agencies annually provide to NMFS the results of scientific research activities directed at threatened salmonids, including a report of the direct take resulting from the studies and a summary of the results of such studies.

(iv) Scientific research activities that may incidentally take threatened salmonids are either conducted by agency personnel, or are in accord with a permit issued by the Agency.

(v) The Agencies provide NMFS annually, for its review and approval, a report listing all scientific research activities it conducts or permits that may incidentally take threatened salmonids during the coming year. Such reports shall also contain the amount of incidental take of threatened salmonids occurring in the previous year's scientific research activities and a summary of the results of such research.

(vi) Electrofishing in any body of water known or suspected to contain threatened salmonids is conducted in accordance with NMFS "Guidelines for Electrofishing Waters Containing Salmonids Listed Under the Endangered Species Act" (NMFS, 2000a).

(vii) NMFS' approval of a research program shall be a written approval by NMFS Northwest or Southwest Regional Administrator.

(8) The prohibitions of paragraph (a) of this section relating to threatened species of salmonids listed in § 223.102(a)(5) through (a)(10), and (a)(12), through (a)(19) do not apply to habitat restoration activities, as defined in paragraph (b)(8)(iv) of this section, provided that the activity is part of a watershed conservation plan, and:

(i) The watershed conservation plan has been certified by the State of Washington, Oregon, Idaho, or California (State) to be consistent with the state's watershed conservation plan guidelines.

(ii) The State's watershed conservation plan guidelines have been found by NMFS to provide for plans that:

(A) Take into account the potential severity of direct, indirect, and cumulative impacts of proposed activities in light of the status of affected species and populations.

(B) Will not reduce the likelihood of either survival or recovery of listed species in the wild.

(C) Ensure that any taking will be incidental.

(D) Minimize and mitigate any adverse impacts.

(E) Provide for effective monitoring and adaptive management.

(F) Use the best available science and technology, including watershed analysis.

(G) Provide for public and scientific review and input.

(H) Include any measures that NMFS determines are necessary or appropriate.

(I) Include provisions that clearly identify those activities that are part of plan implementation.

(J) Control risk to listed species by ensuring funding and implementation of the above plan components.

(iii) NMFS will periodically review state certifications of Watershed Conservation Plans to ensure adherence to approved watershed conservation plan guidelines.

(iv) "Habitat restoration activity" is defined as an activity whose primary purpose is to restore natural aquatic or riparian habitat conditions or processes. "Primary purpose" means the activity would not be undertaken but for its restoration purpose.

(v) Prior to approving watershed conservation plan guidelines under paragraph (b)(8)(ii) of this section, NMFS will publish notification in the **Federal Register** announcing the availability of the proposed guidelines for public review and comment. Such an announcement will provide for a comment period on the draft guidelines of no less than 30 days.

(9) The prohibitions of paragraph (a) of this section relating to threatened species of salmonids listed in § 223.102(a)(5) through (a)(10), and (a)(12) through (a)(19) do not apply to the physical diversion of water from a stream or lake, provided that:

(i) NMFS' engineering staff or any resource agency or tribe NMFS designates (authorized officer) has agreed in writing that the diversion facility is screened, maintained, and operated in compliance with Juvenile Fish Screen Criteria, National Marine Fisheries Service, Northwest Region, Revised February 16, 1995, with Addendum of May 9, 1996, or in California with NMFS' Southwest Region "Fish Screening Criteria for Anadromous Salmonids, January 1997" or with any subsequent revision.

(ii) The owner or manager of the diversion allows any NMFS engineer or authorized officer access to the diversion facility for purposes of inspection and determination of continued compliance with the criteria.

(iii) On a case by case basis, NMFS or an Authorized Officer will review and approve a juvenile fish screen design and construction plan and schedule that the water diverter proposes for screen installation. The plan and schedule will describe interim operation measures to avoid take of threatened salmonids. NMFS may require a commitment of compensatory mitigation if implementation of the plan and schedule is terminated prior to completion. If the plan and schedule are not met, or if a schedule modification is made that is not approved by NMFS or Authorized Officer, or if the screen installation deviates from the approved design, the water diversion will be subject to take prohibitions and mitigation.

(iv) This limit on the prohibitions of paragraph (a) of this section does not encompass any impacts of reduced flows resulting from the diversion or impacts caused during installation of the diversion device. These impacts are subject to the prohibition on take of listed salmonids.

(10) The prohibitions of paragraph (a) of this section relating to threatened species of salmonids listed in § 223.102 (a)(5) through (a)(10), and (a)(12) through (a)(19) do not apply to routine road maintenance activities provided that:

(i) The activity results from routine road maintenance activity conducted by ODOT employees or agents that complies with ODOT's Transportation Maintenance Management System Water Quality and Habitat Guide (July, 1999); or by employees or agents of a state, county, city or port that complies with a program substantially similar to that contained in the ODOT Guide that is determined to meet or exceed the protections provided by the ODOT Guide; or by employees or agents of a state, county, city or port that complies with a routine road maintenance program that meets proper functioning habitat conditions as described further in subparagraph (ii) following. NMFS' approval of state, city, county, or port programs that are equivalent to the ODOT program, or of any amendments, shall be a written approval by NMFS Northwest or Southwest Regional Administrator, whichever is appropriate. Any jurisdiction desiring its routine road maintenance activities to be within this limit must first commit in writing to apply management practices that result in protections equivalent to or better than those provided by the ODOT Guide, detailing how it will assure adequate training, tracking, and reporting, and describing in detail any dust abatement practices it requests to be covered.

(ii) NMFS finds the routine road maintenance activities of any state, city, county, or port to be consistent with the conservation of listed salmonids' habitat when it contributes, as does the ODOT Guide, to the attainment and maintenance of properly functioning condition (PFC). NMFS defines PFC as the sustained presence of natural habitat-forming processes that are necessary for the long-term survival of salmonids through the full range of environmental variation. Actions that affect salmonid habitat must not impair properly functioning habitat, appreciably reduce the functioning of already impaired habitat, or retard the long-term progress of impaired habitat toward PFC. Periodically, NMFS will evaluate an approved program for its effectiveness in maintaining and achieving habitat function that provides for conservation of the listed salmonids. Whenever warranted, NMFS will identify to the jurisdiction ways in which the program needs to be altered or strengthened. Changes may be identified if the program is not protecting desired habitat functions, or where even with the habitat characteristics and functions originally targeted, habitat is not supporting population productivity levels needed to conserve the ESU. If any jurisdiction within the limit does not make changes to respond adequately to the new information in the shortest amount of time feasible, but not longer than one year, NMFS will publish notification in the **Federal Register** announcing its intention to withdraw the limit so that take prohibitions would then apply to the program as to all other activity not within a limit. Such an announcement will provide for a comment period of no less than 30 days, after which NMFS will make a final determination whether to subject the activities to the ESA section 9(a)(1) prohibitions.

(iii) Prior to implementing any changes to a program within this limit the jurisdiction provides NMFS a copy of the proposed change for review and approval as within this limit.

(iv) Prior to approving any state, city, county, or port program as within this limit, or approving any substantive change in a program within this limit, NMFS will publish notification in the **Federal Register** announcing the availability of the program or the draft changes for public review and comment. Such an announcement will provide for a comment period of not less than 30 days.

(v) Pesticide and herbicide spraying is not included within this limit, even if in accord with the ODOT guidance.

(11) The prohibitions of paragraph (a) of this section relating to threatened species of salmonids listed in § 223.102 (a)(5) through (a)(10), and (a)(12) through (a)(19) do not apply to activities within the City of Portland, Oregon Parks and Recreation Department's (PP&R) Pest Management Program (March 1997), including its Waterways Pest Management Policy updated December 1, 1999, provided that:

(i) Use of only the following chemicals is included within this limit on the take prohibitions: Round Up, Rodeo, Garlon 3A, Surfactant LI-700, Napropamide, Cutrine Plus, and Aquashade.

(ii) Any chemical use is initiated in accord with the priorities and decision processes of the Department's Pest Management Policy, including the Waterways Pest Management Policy, updated December 1, 1999.

(iii) Any chemical use within a 25 ft. (7.5 m) buffer complies with the buffer application constraints contained in PP&R's Waterways Pest Management Policy (update December 1, 1999).

(iv) Prior to implementing any changes to this limit, the PP&R provides NMFS with a copy of the proposed change for review and approval as within this limit.

(v) Prior to approving any substantive change in a program within this limit, NMFS will publish notification in the **Federal Register** announcing the availability of the program or the draft changes for public review and comment. Such an announcement will provide for a comment period of no less than 30 days.

(vi) NMFS' approval of amendments shall be a written approval by NMFS Northwest Regional Administrator.

(vii) NMFS finds the PP&R Pest Management Program activities to be consistent with the conservation of listed salmonids' habitat by contributing to the attainment and maintenance of properly functioning condition (PFC). NMFS defines PFC as the sustained presence of a watershed's natural habitat-forming processes that are necessary for the long-term survival of salmonids through the full range of environmental variation. Actions that affect salmonid habitat must not impair properly functioning habitat, appreciably reduce the functioning of already impaired habitat, or retard the long-term progress of impaired habitat toward PFC. Periodically, NMFS will evaluate the effectiveness of an approved program in maintaining and achieving habitat function that provides for conservation of the listed salmonids. Whenever warranted, NMFS will identify to the jurisdiction ways in which the program needs to be altered or strengthened. Changes may be identified if the program is not protecting desired habitat functions, or where even with the habitat characteristics and functions originally targeted, habitat is not supporting population productivity levels needed to conserve the ESU. If any jurisdiction within the limit does not make changes to respond adequately to the new information in the shortest amount of time feasible, but not longer than 1 year, NMFS will publish notification in the **Federal Register** announcing its intention to withdraw the limit so that take prohibitions would then apply to the program as to all other activity not within a limit. Such an announcement will provide for a comment period of no less than 30 days, after which NMFS will make a final determination whether to subject the activities to the ESA section 9(a)(1) prohibitions.

(12) The prohibitions of paragraph (a) of this section relating to threatened species of salmonids listed in § 223.102 (a)(5) through (a)(10), and (a)(12) through (a)(19) do not apply to municipal, residential, commercial, and industrial (MRCI) development (including redevelopment) activities provided that:

(i) Such development occurs pursuant to city, county, or regional government ordinances or plans that NMFS has determined are adequately protective of listed species; or within the jurisdiction of the Metro regional government in Oregon and pursuant to ordinances that Metro has found comply with its Urban Growth Management Functional Plan (Functional Plan) following a determination by NMFS that the Functional Plan is adequately protective. NMFS approval or determinations about any MRCI development ordinances or plans, including the Functional Plan, shall be a written approval by NMFS Northwest or Southwest Regional Administrator, whichever is appropriate. NMFS will apply the following 12 evaluation considerations when reviewing MRCI development ordinances or plans to assess whether they adequately conserve listed salmonids by maintaining and restoring properly functioning habitat conditions:

(A) MRCI development ordinance or plan ensures that development will avoid inappropriate areas such as unstable slopes, wetlands, areas of high habitat value, and similarly constrained sites.

(B) MRCI development ordinance or plan adequately avoids stormwater discharge impacts to water quality and quantity or to the hydrograph of the watershed, including peak and base flows of perennial streams.

(C) MRCI development ordinance or plan provides adequately protective riparian area management requirements to attain or maintain PFC around all rivers, estuaries, streams, lakes, deepwater habitats, and intermittent streams. Compensatory mitigation is provided, where necessary, to offset unavoidable damage to PFC due to MRCI development impacts to riparian management areas.

(D) MRCI development ordinance or plan avoids stream crossings by roads, utilities, and other linear development wherever possible, and, where crossings must be provided, minimize impacts through choice of mode, sizing, and placement.

(E) MRCI development ordinance or plan adequately protects historical stream meander patterns and channel migration zones and avoids hardening of stream banks and shorelines.

(F) MRCI development ordinance or plan adequately protects wetlands and wetland functions, including isolated wetlands.

(G) MRCI development ordinance or plan adequately preserves the hydrologic capacity of permanent and intermittent streams to pass peak flows.

(H) MRCI development ordinance or plan includes adequate provisions for landscaping with native vegetation to reduce need for watering and application of herbicides, pesticides, and fertilizer.

(I) MRCI development ordinance or plan includes adequate provisions to prevent erosion and sediment run-off during construction.

(J) MRCI development ordinance or plan ensures that water supply demands can be met without impacting flows needed for threatened salmonids either directly or through groundwater withdrawals and that any new water diversions are positioned and screened in a way that prevents injury or death of salmonids.

(K) MRCI development ordinance or plan provides necessary enforcement, funding, reporting, and implementation mechanisms and formal plan evaluations at intervals that do not exceed 5 years.

(L) MRCI development ordinance and plan complies with all other state and Federal environmental and natural resource laws and permits.

(ii) The city, county or regional government provides NMFS with annual reports regarding implementation and effectiveness of the ordinances, including: any water quality monitoring information the jurisdiction has available; aerial photography (or some other graphic display) of each MRCI development or MRCI expansion area at sufficient detail to demonstrate the width and vegetation condition of riparian set-backs; information to demonstrate the success of stormwater management and other conservation measures; and a summary of any flood damage, maintenance problems, or other issues.

(iii) NMFS finds the MRCI development activity to be consistent with the conservation of listed salmonids' habitat when it contributes to the attainment and maintenance of PFC. NMFS defines PFC as the sustained presence of a watershed's habitat-forming processes that are necessary for the long-term survival of salmonids through the full range of environmental variation. Actions that affect salmonid habitat must not impair properly functioning habitat, appreciably reduce the functioning of already impaired habitat, or retard the long-term progress of impaired habitat toward PFC. Periodically, NMFS will evaluate an approved program for its effectiveness in maintaining and achieving habitat function that provides for conservation of the listed salmonids. Whenever warranted, NMFS will identify to the jurisdiction ways in which the program needs to be altered or strengthened. Changes may be identified if the program is not protecting desired habitat functions, or where even with the habitat characteristics and functions originally targeted, habitat is not supporting population productivity levels needed to conserve the ESU. If any jurisdiction within the limit does not make changes to respond adequately to the new information in the shortest amount of time feasible, but not longer than 1 year, NMFS will publish notification in the **Federal Register** announcing its intention to withdraw the limit so that take prohibitions would then apply to the program as to all other activity not within a limit. Such an announcement will provide for a comment period of no less than 30 days, after which NMFS will make a final determination whether to subject the activities to the ESA section 9(a)(1) prohibitions.

(iv) Prior to approving any city, county, or regional government ordinances or plans as within this limit, or approving any substantive change in an ordinance or plan within this limit, NMFS will publish notification in the **Federal Register** announcing the availability of the ordinance or plan or the draft changes for public review and comment. Such an announcement will provide for a comment period of no less than 30 days.

(13) The prohibitions of paragraph (a) of this section relating to threatened

species of salmonids listed in § 223.102 (a)(12), (a)(13), (a)(16), (a)(17), and (a)(19) do not apply to non-Federal forest management activities conducted in the State of Washington provided that:

(i) The action is in compliance with forest practice regulations adopted and implemented by the Washington Forest Practices Board that NMFS has found are at least as protective of habitat functions as are the regulatory elements of the Forests and Fish Report dated April 29, 1999, and submitted to the Forest Practices Board by a consortium of landowners, tribes, and state and Federal agencies.

(ii) All non-regulatory elements of the Forests and Fish Report are being implemented.

(iii) Actions involving use of herbicides, pesticides, or fungicides are not included within this limit.

(iv) Actions taken under alternative plans are included in this limit provided that the Washington Department of Natural Resources (WDNR) finds that the alternate plans protect physical and biological processes at least as well as the state forest practices rules and provided that NMFS, or any resource agency or tribe NMFS designates, has the opportunity to review the plan at every stage of the development and implementation. A plan may be excluded from this limit if, after such review, WDNR determines that the plan is not likely to adequately protect listed salmon.

(v) Prior to determining that regulations adopted by the Forest Practice Board are at least as protective as the elements of the Forests and Fish Report, NMFS will publish notification in the **Federal Register** announcing the availability of the Report and regulations for public review and comment.

(vi) NMFS finds the activities to be consistent with the conservation of listed salmonids' habitat by contributing to the attainment and maintenance of PFC. NMFS defines PFC as the sustained presence of a watershed's natural habitat-forming processes that are necessary for the long-term survival of salmonids through the full range of environmental variation. Actions that affect salmonid habitat must not impair properly functioning habitat, appreciably reduce the functioning of already impaired habitat, or retard the long-term progress of impaired habitat toward PFC. Programs must meet this biological standard in order for NMFS to find they qualify for a habitat-related limit. NMFS uses the best available science to make these determinations. NMFS may review and revise previous findings as new scientific information becomes available. NMFS will evaluate the effectiveness of the program in maintaining and achieving habitat function that provides for conservation of the listed salmonids. If the program is not adequate, NMFS will identify to the jurisdiction ways in which the program needs to be altered or strengthened. Changes may be identified if the program is not protecting desired habitat functions or where even with the habitat characteristics and functions originally targeted, habitat is not supporting population productivity levels needed to conserve the ESU. If Washington does not make changes to respond adequately to the new information, NMFS will publish notification in the **Federal Register** announcing its intention to withdraw the limit on activities associated with the program. Such an announcement will provide for a comment period of no less than 30 days, after which NMFS will make a final determination whether to subject the activities to the ESA section 9(a)(1) take prohibitions.

(vii) NMFS approval of regulations shall be a written approval by NMFS Northwest Regional Administrator.

(c) *Affirmative defense.* In connection with any action alleging a violation of the prohibitions of paragraph (a) of this section with respect to the threatened species of salmonids listed in § 223.102 (a)(5) through (a)(10), and (a)(12) through (a)(19), any person claiming the benefit of any limit listed in paragraph (b) of this section or § 223.209(a) shall have a defense where the person can demonstrate that the limit is applicable and was in force, and that the person fully complied with the limit at the time of the alleged violation. This defense is an affirmative defense that must be raised, pleaded, and proven by the proponent. If proven, this defense will be an absolute defense to liability under section (a)(1)(G) of the ESA with respect to the alleged violation.

(d) *Severability.* The provisions of this section and the various applications thereof are distinct and severable from one another. If any provision or the application thereof to any person or circumstances is stayed or determined to be invalid, such stay or invalidity shall not affect other provisions, or the application of such provisions to other persons or circumstances, which can be given effect without the stayed or invalid provision or application.

[FR Doc. 00–16933 Filed 7–7–00; 8:45 am]

BILLING CODE 3510–22–F

DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

50 CFR Part 223

[Docket No. 991207318–0159–02; I.D. No 092799G]

RIN 0648–AG15

Limitation on Section 9 Protections Applicable to Salmon and Steelhead Listed as Threatened under the Endangered Species Act (ESA), for Actions Under Tribal Resource Management Plans

AGENCY: National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration (NOAA), Commerce.

ACTION: Final rule.

SUMMARY: The National Marine Fisheries Service (NMFS) is issuing a final rule to modify the ESA section 9 take prohibitions applied to threatened salmon and steelhead. The modification will create a section 4(d) limitation on those prohibitions for tribal resource management plans (Tribal Plans), where the Secretary of Commerce (Secretary) has determined that implementing that Tribal Plan will not appreciably reduce the likelihood of survival and recovery for the listed species. This rule intends to harmonize statutory conservation requirements with tribal rights and the Federal trust responsibility to tribes.

DATES: Effective September 8, 2000.

ADDRESSES: Branch Chief, NMFS, Northwest Region, Protected Resources Division, 525 NE. Oregon St., Suite 500, Portland, OR 97232–2737; Assistant Regional Administrator, Protected Resources Division, NMFS, Southwest Region, 501 West Ocean Blvd., Suite 4200, Long Beach, CA 90802-4213; Salmon Coordinator, Office of Protected Resources, NMFS, 1315 East-West Highway, Silver Spring, MD 20910.

FOR FURTHER INFORMATION CONTACT: Garth Griffin at 503-231-2005; Craig Wingert at 562–980–4021.

Electronic Access

Reference materials regarding this final rule can also be obtained from the internet at www.nwr.noaa.gov.

SUPPLEMENTARY INFORMATION:

Definitions

Indian Tribe—Any Indian tribe, band, nation, pueblo, community or other organized group within the United States which the Secretary of the Interior has identified on the most current list of tribes maintained by the

A Citizen's Guide to the 4(d) Rule

For

Threatened Salmon and Steelhead on the West Coast

National Marine Fisheries Service
Northwest and Southwest Regions
June 20, 2000

Table of Contents

Introduction

In June 2000, the National Marine Fisheries Service (NMFS) adopted a rule prohibiting the "take" of 14 groups of salmon and steelhead listed as threatened under the Endangered Species Act (ESA). NMFS adopted the take rule under section 4(d) of the ESA. This rule prohibits anyone from taking a listed salmon or steelhead, *except* in cases where the take is associated with an approved program. The 4(d) rule approves some specific existing state and local programs, and create a means for NMFS to approve additional programs if they meet certain standards set out in the rule.

State and local governments, tribes and others throughout the Northwest have stepped forward and assumed leadership roles in saving these species. Efforts include the Oregon Plan for Salmon and Watersheds, the State of Washington's Extinction is Not an Option Plan, Metro's Functional Plan, the Puget Sound Tri-County Initiative, the Lower Columbia Fish Recovery Board, the Eugene, Oregon-area Metro ESA Coordinating Team, and the Willamette Restoration Initiative. NMFS believes it is these local efforts that will ultimately save the salmon. A central goal of this 4(d) rule is to encourage such state and local efforts by providing the means for NMFS to approve local efforts and limit liability under the ESA.

Background

Purpose of this Guide

This *Citizen's Guide to the 4(d) Rule* introduces and explains the rule. It complements the final rule published in the *Federal Register* in June of 2000 by providing a more user-friendly description of why the rule is needed, what it contains, how it will affect citizens, and how to get more information. This Guide is not binding Federal language or regulation. Individuals should refer to the Federal register notice for the regulatory language governing activities under the rule.

Salmon in Decline

In 1994, in response to growing concerns about salmon health on the West Coast, NMFS began the most thorough scientific review of Pacific salmon ever undertaken. The review looked at salmon and steelhead from desert-like areas in California to coastal rain forests, and from the high mountains of central Idaho to lowland basins within sight of the Pacific Ocean. The review identified 52 distinct populations, known as Evolutionarily Significant Units (or ESUs) of Pacific salmon in Oregon, Washington, Idaho, and California. Of these populations, 26 have been listed as threatened or endangered under the ESA and most others are in decline or at very low levels.

These populations of salmon and steelhead are likely to become endangered species within the foreseeable future and their current threatened status cannot be explained by ocean cycles or other natural events. NMFS has concluded that these species are at risk of extinction primarily due to human activities. Salmon and steelhead populations have been depleted by over-fishing, past and ongoing habitat destruction, hydropower development, hatchery practices, degraded water quality and other causes.

Chum Salmon: Populations are down throughout Oregon and Washington. Summer-run chum have disappeared from many Hood Canal streams, and numbers in the Columbia Basin have declined to less than one percent of their former abundance.

Chinook Salmon: Only two of 13 different stocks in Puget Sound are considered healthy. Only slightly more an 1,000 fish return annually to the entire Willamette Basin. Recent returns of spring-run Chinook to the Upper Columbia have averaged only 5,000 naturally-produced fish and are the lowest on record.

Steelhead: Willamette River fish are in steep decline and returns during 1995 were the lowest in 30 years of record keeping. Returns have dropped to as low as 500 fish in the middle Columbia rivers like the Yakima and Umatilla, and steelhead are extinct in the Crooked and Metolius rivers in Oregon.

A species is considered *endangered* when it is "in danger of extinction throughout all or a significant portion of its range" and *threatened* when it is "likely to become endangered within the foreseeable future throughout all or a significant portion of its range." Copies of these studies are available to the public and can be obtained by calling any of the NMFS offices listed at the end of this Guide, or one of our websites at www.nwr.noaa.gov or swr.ucsd.edu.

Saving the Salmon

The ESA provides a variety of tools for saving species threatened with extinction. Under section 7 of the ESA, no Federal agency may fund, permit or carry out any activity that will jeopardize their continued existence. In many cases, this restriction on Federal activity is not enough by itself to recover threatened species. When the activities of state and local governments and private citizens harm listed species, section 4(d) of the ESA requires that harm be controlled so it does not lead to extinction.

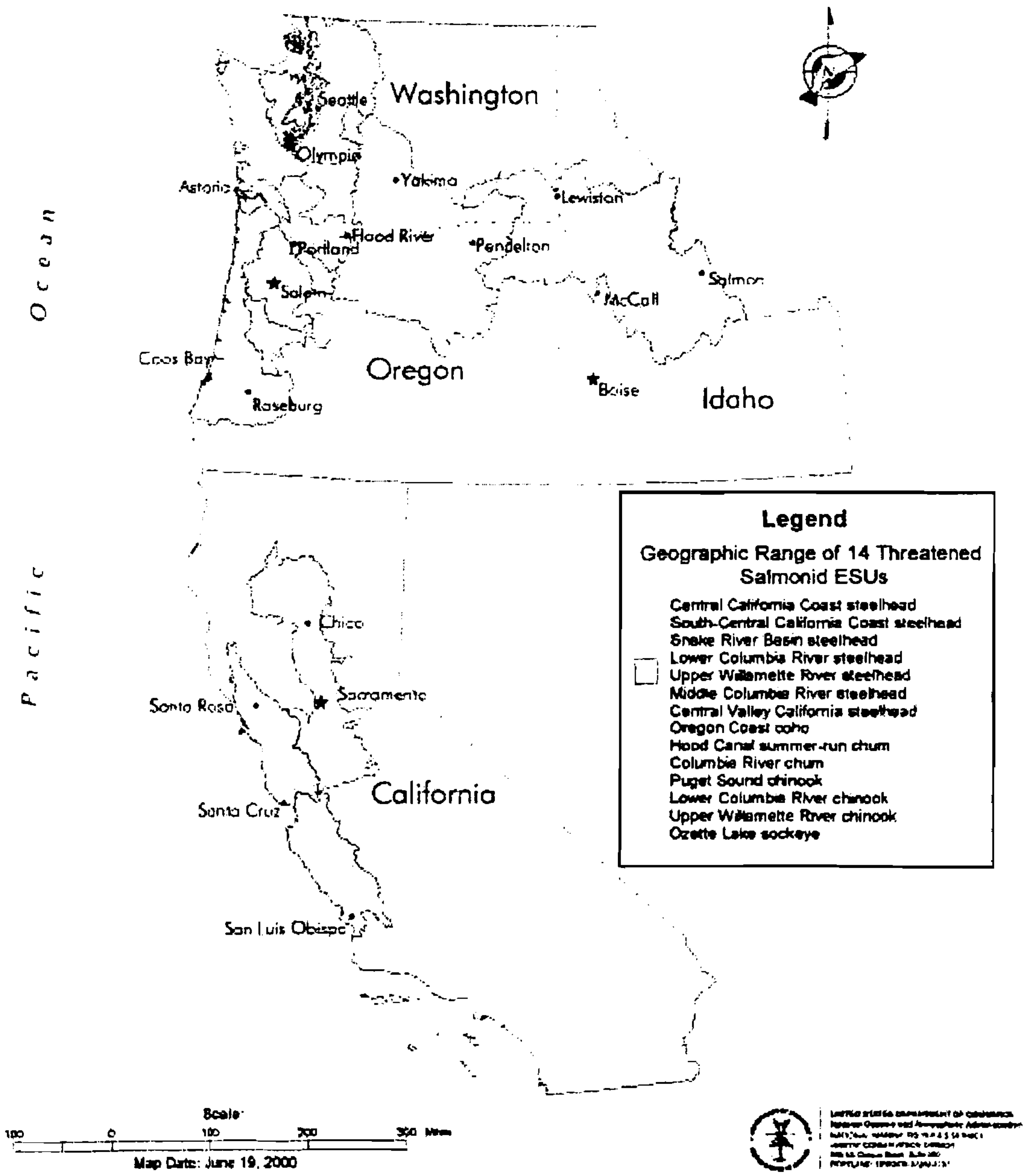
Section 4(d) requires NMFS to issue regulations deemed "necessary and advisable to provide for the conservation of the species." NMFS must establish protective rules for all species now listed as threatened under the ESA. These protective rules for threatened species may apply any or all of the ESA section 9 protections that automatically prohibit take of species listed as endangered. The rules need not prohibit all take. There may be an "exception" from the prohibitions on take so long as the take occurs as the result of a program that adequately protects the listed species and its habitat. In other words, the 4(d) rule can "limit" the situations to which the take prohibitions apply.

Incorporating such "limits" into a 4(d) rule can be good for NMFS, state agencies, government entities, private citizens, and the fish. Activities carried out in accordance with 4(d) rule limits can help protect threatened species and their habitats while relieving state agencies, government entities, tribes and others from liability for take that results from those activities. By providing limitation from take liability, NMFS encourages governments and private citizens to adjust their programs and activities to be "salmon safe." NMFS anticipates that programs and activities included as a 4(d) rule limit will ultimately be incorporated into ESA Recovery Plans for listed salmon and steelhead.

What does the 4(d) Rule do?

This rule protects 14 ESUs of salmon and steelhead in Idaho, Washington, Oregon, and California (depicted in the map on the following page). The rule follows the standard practice of prohibiting the killing or injuring of a threatened species (i.e. "take") without specific written authorization; that is its principal function.

Final 4(d) Rule for 14 Salmon and Steelhead ESUs



* An Evolutionarily Significant unit or "ESU" is a distinctive group of Pacific salmon or steelhead

The rule applies to ocean and inland areas, and to any authority, agency, or private individual subject to U. S. jurisdiction. Activities or development not likely to kill or harm protected species will not be affected by the rule. The rule does not prohibit actions or programs—it prohibits illegal take. Activities that do not kill or injure protected salmon and steelhead do not require any special authorization. Limits can be thought of as "exceptions" to the take prohibitions. These limits represent programs or activities, or criteria for future programs or activities, for which NMFS will not apply the take prohibitions. This is because NMFS has determined that these programs or activities minimize impacts on threatened salmon and steelhead enough so that additional Federal protections are not needed to conserve the ESU. NMFS will monitor the activities that have been granted a limit to make certain there is no unexpected take or harm.

What is Take?

The ESA makes it illegal for any person subject to the jurisdiction of the United States to take any species of fish or wildlife that is listed as endangered (ESA section 9[a][1]) without specific authorization. The final 4(d) rule puts in place the same take prohibitions for threatened salmon and steelhead, except for certain limits that apply to the activities specified in the rule. This prohibitions applies within the United States and its territorial waters as well as on the high seas.

"Take" is defined as "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct" (ESA section 3[19]). It is also illegal under ESA section 9 to possess, sell, deliver, carry, transport, or ship any species that has been taken illegally (ESA section 9[a][1]). Violating the take prohibitions may result in civil or criminal penalties.

"Harass" is defined as an intentional or negligent act that creates the likelihood of injuring wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns such as breeding, feeding, or sheltering (50 CFR 17.3).

"Harm" is defined as an act that actually kills or injures a protected species (50 CFR 222.102 (64FR 60727)). Harm can arise from significant habitat modification or degradation where it actually kills or injures protected species by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering.

Take Guidance

The likelihood that an action will take a listed species must be evaluated on a case-by-case basis. NMFS has described the kinds of activities (e.g., blocking fish from reaching spawning and rearing areas, illegal fishing etc.), that are likely to injure or kill threatened salmon and steelhead in a "Take Guidance" section in the Federal Register Notice. ***This guidance is not regulatory.*** Rather it provides guidance on what actions are very likely to take threatened species and identifies where NMFS will focus its enforcement actions. This is not a list of prohibited activities.

Based on available information, NMFS believes the categories of activities listed below are those activities that, as a general rule, are most likely to harm listed fish. NMFS wishes to emphasize at the outset that the potential for these activities to harm listed salmon and steelhead depends entirely upon the facts and circumstances of each case. The mere fact that an activity may fall within one of these categories does not automatically mean that it causes harm. These types of activities are, however, those most likely to cause harm and thereby violate this rule. NMFS' ESA enforcement will focus on these categories of activities.

A. Constructing or maintaining structures like culverts, berms, or dams that eliminate or impede a listed species' ability to migrate or gain access to habitat.

B. Discharging pollutants, such as oil, toxic chemicals, radioactivity, carcinogens, mutagens, teratogens, or organic nutrient-laden water (including sewage water) into a listed species' habitat.

C. Removing, poisoning, or contaminating plants, fish, wildlife, or other biota that the listed species requires for feeding, sheltering, or other essential behavioral patterns.

D. Removing or altering rocks, soil, gravel, vegetation or other physical structures that are essential to the integrity and function of a listed species' habitat.

E. Removing water or otherwise altering streamflow in a manner that significantly impairs spawning, migration, feeding, or other essential behavioral patterns.

F. Releasing non-indigenous or artificially propagated species into a listed species' habitat or into areas where they may gain access to that habitat.

G. Constructing or operating dams or water diversion structures with inadequate fish screens or passage facilities.

H. Constructing, maintaining, or using inadequate bridges, roads, or trails on stream banks or unstable hill slopes adjacent to or above a listed species' habitat.

I. Conducting timber harvest, grazing, mining, earth-moving, or other operations that substantially increase the amount of sediment going into streams.

J. Conducting land-use activities that may disturb soil and increase sediment delivery to streams—such as logging, grazing, farming, and road construction—in riparian areas and areas susceptible to mass wasting and surface erosion.

K. Illegal fishing. Harvest that violates fishing regulations will be a top enforcement concern.

L. Various streambed disturbances may trample eggs or trap adult fish preparing to spawn. The disturbance could be mechanical disruption caused by constructing push-up dams, removing gravel, mining, or other work in a stream channel. It may also take the form of egg trampling or smothering by livestock in the streambed or by vehicles or equipment being driven across or down the streambed (as well as any similar physical disruptions).

M. Illegal interstate and foreign commerce dealing in, imports, or exports listed salmon or steelhead.

N. Altering lands or waters in a manner that promotes unusual concentrations of predators.

O. Shoreline and riparian disturbances (whether in the river, estuary, marine, or floodplain environment) may retard or prevent the development of certain habitat characteristics upon which the fish depend (e.g., removing riparian trees reduces vital shade and cover, floodplain gravel mining, development, and armoring shorelines reduces the input of critical spawning substrates, and bulkhead construction can eliminate shallow water rearing areas).

P. Filling or isolating side channels, ponds, and intermittent waters (e.g., installing tide gates and impassable culverts) can destroy habitats that the fish depend upon for refuge during high flows.

This list is not exhaustive. It is simply intended to help people avoid violating the ESA and to encourage efforts to save the species. Determining whether take has actually occurred depends on the circumstances of a particular case. Many activities that may kill or injure salmon are regulated by state or Federal rules such as fill and removal authorities, National Pollutant Discharge Elimination System or other water quality permitting, pesticide use, and the like. For those types of activities, NMFS would not tend to focus enforcement efforts on those who operate in conformity with current permits. Rather, if the regulatory program does not provide adequate protection, NMFS will work with the responsible agency to make necessary changes in the program.

For example, concentrations of pesticides may affect salmon behavior and reproduction. Current EPA label requirements were developed without information about some of these subtle but real impacts on aquatic species such as salmon. And they were not developed with the intent of protecting or recovering threatened salmon. Where new information indicates that label requirements do not adequately protect salmon, NMFS will work with EPA through the section 7 consultation process to develop more protective use restrictions, and thereby provide the best possible guidance to all users. Similarly, where water quality standards or state authorizations lead to pollution levels that may cause take, NMFS intends to work with the state water quality agencies and EPA to bring those standards (or permitting programs) to a point that does protect salmon.

Those who believe their activities are likely to injure or kill salmon are encouraged to immediately change that activity to avoid take (or adequately limit any impacts on the species) and seek NMFS' authorization for incidental take under either (a) an ESA section 10 incidental take permit; (b) an ESA section 7 consultation; or (c) a limit on the take prohibitions provided in this rule. The public is encouraged to contact NMFS (see contact list) for help in determining whether circumstances at a particular location (involving these activities or any others) constitute a take in violation of the 4(d) rule.

Take of listed fish resulting from actions in compliance with a permit issued by NMFS under section 10 of the ESA do not violate this rule. Section 10 permits may be issued for research activities, activities that enhance a species' survival, or to authorize incidental take occurring in the course of an otherwise lawful activity. In addition, NMFS consults—under section 7 of the ESA—on a broad range of activities conducted, funded, or authorized by Federal agencies. These include fish harvest, hatchery operations, silviculture activities, grazing, mining, road construction, dam construction and operation, fill material discharge, and stream channelization and diversion. Federally funded or approved activities for which ESA section 7 consultations have been completed will not constitute violations of this rule—provided the activities are conducted in accord with all reasonable and prudent measures and the terms and conditions stated in the incidental take statement.

Evaluating Potential ESA Take Liability

The June, 2000 4(d) rule's prohibitions on take applies to the activities of everyone—every state, city, and county government, every business, and every citizen. The Take Guidance provides information about what types of activities may be most likely to cause harm and thus violate the 4(d) rule. However, each activity and circumstance must be evaluated on a case by case basis to determine if it is likely to cause a take. After reviewing the take guidance, many governmental entities, businesses, and individuals may question how the 4(d) rule and its take guidance affects them. Any governmental entity, business or individual can use the following risk assessment evaluation steps:

(1) Identify the program or activity (for state and local governments, this may include activities it funds, authorizes, or carries out);
(2) Evaluate whether the program or activity is likely to take or harm listed fish;
(3) If the program or activity is not likely to take or harm listed fish, then there is no need to modify the activity, or to contact NMFS;
(4) If, however, after reviewing the program or activity, it seems likely it will take or harm listed fish, or there is uncertainty about whether take or harm may occur, the acting agency, entity, or individual should contact NMFS to seek more information on evaluating the activity's impacts and determining ways to avoid harming the fish and violating the ESA.

There are many sources of information on improved best management practices to avoid take or harm and to reduce ESA liabilities. In addition, professional associations, state and Federal resource management agencies that provide technical information to landowners and others, watershed councils and non-governmental organization can be important sources of information about how to modify activities to avoid or reduce impacts on threatened salmon and steelhead.

Effective Dates

State, tribal, and local governments, stakeholder groups, and citizens across four states need to familiarize themselves with the guidance provided in the rule, assess the consequences of their individual authorities and activities, and make any necessary adjustments to protect the fish. After sufficient time to review the new rule, NMFS will hold a number of public forums in rural and metropolitan communities to engage interested parties in constructive discussion about salmon recovery. For these reasons, the 4(d) rule for chinook, coho, chum, and sockeye salmon will take effect 180 days after it is published in the *Federal Register*. Those in the range of threatened steelhead have had more notice that efforts to save the fish are needed, so the 4(d) rule for steelhead will take effect 60 days after publication.

A 1997 interim 4(d) rule (published in 1997) remains in place for the Southern Oregon/Northern California Coast (SONCC) coho ESU. The SONCC 4(d) rule included several limitations based on adequately protective state programs in Oregon and provided a model for developing the three 4(d) rules proposed in January of 2000. The final 4(d) rule for 14 additional threatened ESUs does not affect this earlier rule.

Useful Concepts for Understanding the Limits

The final rule incorporates two scientific concepts NMFS will use when determining whether particular programs may receive limits on the take protections. The first applies primarily to harvest and hatchery activities, and is described in a scientific paper entitled *"Viable Salmonid Populations and the Recovery of Evolutionarily Significant Units"* (NMFS 2000). The Viable Salmonid Population (VSP) paper describes the importance of identifying individual populations within an ESU, and the importance of identifying abundance levels and other characteristics that may be considered "critical" (where abundance is so low the population requires special protections) or "viable" (where abundance is high enough the population may be considered healthy). Generally, programs and activities will receive a 4(d) limit only if they do not increase the risks to critical populations, and if they do not preclude populations from attaining or maintaining viability.

The second concept applies to programs and activities that affect salmon habitat. For habitat, NMFS uses the concept of Proper Functioning Condition (PFC). Properly functioning habitat is habitat that provides for the biological requirements of the fish. PFC is defined in terms of the natural processes and functions that lead to habitat conditions that will meet the biological requirements of the fish. NMFS offers 4(d) limits only for those programs or activities that will not impair properly functioning habitat, appreciably reduce the functioning of already impaired habitat, or will not retard the long-term progress of impaired habitat toward PFC.

The concepts of VSP and PFC are described in more detail at the end of this guide.

The 13 Limits

When the final 4(d) rule becomes effective, the take prohibitions will apply to actions carried out by state, tribal, and local governments and private parties that take listed salmon and steelhead, except take that is associated with those activities that come under one of the 4(d) limits and those already permitted under other sections of the ESA. The take prohibitions would be limited for the programs and activities identified in the 4(d) rule because NMFS has determined that they impacts on threatened fish sufficiently that additional Federal protections are not needed.

The final rule describes two types of limits on the take prohibitions. One type includes specific programs NMFS has already reviewed and determined will minimize harm to threatened fish or contribute to their conservation. The other type includes general categories of programs that NMFS may evaluate in the future. For this second type of limit, the 4(d) rule sets out the standards NMFS will use when it reviews activities and programs for inclusion in the rule, how the public will be given notice in the *Federal Register* of the opportunity to review the program being submitted and, if the limit is determined to sufficiently conserve the listed species, how it will be approved by the Northwest or Southwest Regional Administrator, whichever is appropriate. NMFS has also established a process for periodically evaluating the limits, making recommendations for adjusting the programs, and alerting the public in cases when the limit would be withdrawn and take prohibitions re-applied.

Some of the broad categories of activities covered by limits in the final rule are:

- Scientific research conducted or supervised by, or coordinated with, state fishery agencies
- Fish harvest activities
- Artificial propagation programs
- Habitat restoration based on watershed plans
- Properly screened water diversions
- Routine road maintenance
- Municipal, residential, commercial, and industrial development and redevelopment
- Forest management practices in the State of Washington

NMFS is not requiring states, local governments or private parties to change their practices to conform to any of the take limits described in the final rule. The limits provide one way to be sure an activity or program does not risk violating the take prohibitions. Simply because a program is not within a limit *does not* mean that it automatically violates the ESA or the 4(d) rule. However, it *does* mean that any program or jurisdiction would risk ESA penalties if the activity in question takes a listed fish. By receiving a limit, governments and individuals receive assurance that their activities do not violate the take prohibitions and will not be subject to enforcement.

Description of the Limits

Limit No. 1 – ESA Permits

This limit recognizes that those holding permits under section 10 of the ESA (or receiving other exemptions under the ESA) are free of the take prohibitions so long as they act in accordance with the permit or applicable law. Land management activities associated with a habitat conservation plan and scientific research are examples of activities for which a section 10 permit may be issued.

Limit No. 2 – Ongoing Scientific Research

This final rule does not restrict ongoing scientific research that affects threatened ESUs for up to eight months (i.e., through February 2001) provided an application for a research or enhancement permit reaches the Assistant Administrator for Fisheries, NOAA, within 90 days after the rule is published. The take prohibitions will extend to these activities if the Assistant Administrator rejects an application as insufficient, if a permit is denied, or if six months have elapsed since the effective date of the final rule, whichever occurs earliest. It is in the interest of conservation to not disrupt ongoing research and conservation projects, some of which are of long duration. This limit on the take prohibitions ensures there will be no unnecessary disruption of those activities yet provides NMFS with the ability to halt the activity if it will have unacceptable impacts on a listed ESU.

Limit No. 3 – Rescue and Salvage Actions

This limit relieves certain agency and official personnel (or their designees) from the take prohibitions when they are acting to aid an injured or stranded fish or salvage a dead fish for scientific study. Each agency acting under this limit is to report the numbers of fish handled and their status on an annual basis. This limit on the take prohibitions will conserve the listed species by preserving life or furthering our understanding of the species' biology.

Limit No. 4 – Fishery Management

NMFS believes recreational, commercial, and tribal fisheries can be managed to protect salmon and steelhead listed under the ESA and allow them to recover. The 4(d) rule provides a way to permit the "take" of listed fish in fisheries. A fishery management agency can develop a Fisheries Management and Evaluation Plan (FMEP) and seek NMFS' approval for it. Some of the benefits of the FMEP approach are long-term management planning, more public involvement, less government paperwork, and more certainty that there will be fishing opportunities in the future.

NMFS will use the same standard to evaluate FMEPs as those used for section 10 permits: the fisheries must not jeopardize listed salmon and steelhead, nor lessen the protection they receive. In the FMEPs, fisheries will be managed according to the listed fishes' status. This will be determined by using the concept of "Viable Salmonid Populations." Fisheries will be scaled to the degree of risk the listed fish face. When a listed population is at a "critically" low level, harvest impacts will be strictly controlled. Once a population achieves a "viable" level, fisheries could be less restrictive.

An FMEP must address the specific criteria outlined in the 4(d) rule. An FMEP must (1) define its objectives and management area, (2) define the populations within the affected ESUs, (3) establish the populations' "critical" and "viable" threshold levels, (4) set escapement objectives or maximum harvest rates, (5) demonstrate that the fisheries will not jeopardize listed fish, (6) establish the monitoring and evaluation process to assess how the FMEP is working and set conditions for revising management, and (7) be consistent with tribal trust obligations. All of these criteria were developed to answer the following questions: Where and how should the fisheries occur? What are their impacts on listed fish? How can it be demonstrated that an FMEP conserves listed fish and allows their recovery?

FMEPs are developed and approved in the following manner: A fish management agency, such as a state department of fish and wildlife, develops an FMEP that meets the 4(d) rule criteria. They send it to NMFS who then requests public review and comment. The public input is used to revise the FMEP, if necessary. Once the FMEP is deemed sufficient, NMFS writes a letter of approval to the agency that developed the FMEP. The FMEP is then implemented and the fisheries addressed in the FMEP will be covered under the ESA. NMFS then monitors and evaluates the FMEP to ensure that the listed fish are recovering.

Limit No. 5 – Artificial Propagation

NMFS believes hatcheries can be managed in a manner that conserves and recovers salmon and steelhead listed under the ESA. Therefore, the 4(d) rule provides a way to permit the "take" of listed fish for a variety of hatchery purposes. A state or Federal hatchery management agency can develop a Hatchery and Genetics Management Plan (HGMP) and seek NMFS' approval. Some of the benefits of the HGMP approach are long-term management planning, more public involvement, and less government paperwork.

NMFS will use the same standard to evaluate HGMPs as those used for section 10 permits: the hatchery program must not jeopardize listed salmon and steelhead, nor lessen the protection they receive. In the HGMPs, hatcheries will be managed according to the listed fishes' status. This will be determined using the concept of "Viable Salmonid Populations." Hatchery activities will be scaled to the degree of risk the listed fish face. When a listed population is at a "critical" level, broodstock collection will be strictly controlled. Once a population achieves a "viable" level, broodstock collection could be less restrictive.

An HGMP must address the specific criteria outlined in the 4(d) rule. An HGMP must (1) specify the goals and objectives for the hatchery program, (2) the donor population's "critical" and "viable" threshold levels, (3) prioritize broodstock collection programs in a manner that benefits listed fish, (4) specify the protocols that will be used for spawning and raising the fish in the hatchery, (5) determine the genetic and ecological effects arising from the hatchery program, (6) describe how the hatchery operation relates to fisheries management, (7) ensure that the hatchery facilities can adequately accommodate listed fish if they are collected for the program, (8) monitor and evaluate the HGMP to ensure that it accomplishes its objectives, and (9) be consistent with tribal trust obligations.

HGMPs are developed and approved in the following manner: A fish management agency, such as a state department of fish and wildlife, develops an HGMP that meets the 4(d) rule criteria. They send it to NMFS who then requests public review and comment. The public input is used to revise the HGMP, if necessary. Once the HGMP is deemed sufficient, NMFS writes a letter of approval to the agency that developed the HGMP. The HGMP is then implemented and the hatchery program addressed in the FMEP will be covered under the ESA. NMFS then monitors and evaluates the HGMP to ensure that the listed fish are recovering.

Limit No. 6 – Joint Tribal/State Plans Developed under the *United States v. Washington* or *United States v. Oregon* Settlement Processes

Non-tribal salmonid management in the Puget Sound and Columbia River areas is profoundly influenced by the fishing rights of numerous Indian tribes and must be responsive to the court proceedings that interpret and define those tribal rights. Various orders of the *United States v. Washington* court, such as the Puget Sound Salmon Management Plan (originally approved by the court in 1977; recently amended in *United States v. Washington*, 626 F. Supp. 1405, 1527 (1985, W.D. Wash.)), mandate that many aspects of fishery management, including but not limited to harvest and artificial production actions, be jointly coordinated by the State of Washington and the Western Washington Treaty tribes. The State of Washington, affected tribes, other interests, and Federal agencies are all working toward an integrated set of management strategies and strictures that respond to the biological, legal, and practical realities of salmon management in Puget Sound. Similar principles apply in the Columbia River basin where the States of Oregon, Washington, and Idaho and five treaty tribes work within the framework and jurisdiction of *United States v. Oregon*.

NMFS includes this limit on the take prohibitions to accommodate any resource management plan developed jointly by the States and the Tribes (joint plan) under the jurisdiction of *United States v. Washington* or *United States v. Oregon*. Such a plan would be developed and reviewed under the government-to-government processes outlined in the final 4(d) rule for Tribal Resource Management Plans. Before any joint plan receives a limit on the take prohibitions, the Secretary must, after taking into account any public comment on the plan, determine that it will not appreciably reduce the likelihood of the listed species' survival and recovery. The Secretary shall publish in the Federal Register notice of any determination regarding a joint plan; the notice will include a discussion of the biological analysis underlying the determination.

NMFS will evaluate joint plans on a regular basis to determine if they sufficiently protect and conserve the listed fish.

Limit No. 7 – Scientific Research

In carrying out their responsibilities, state fishery management agencies in Washington, Oregon, Idaho, and California conduct or permit a wide range of scientific research activities on various fisheries. These include monitoring programs and other studies of the 14 ESUs affected by the final rule. In general, NMFS finds that such activities will help conserve the listed species by furthering our understanding of the species' status, risks, life history, and biological requirements, and that state biologists and cooperating agencies carefully consider the benefits and risks entailed in proposed research before approving or undertaking such projects. NMFS concludes it is not necessary and advisable to impose additional protections on such research by imposing of Federal take prohibitions, and NMFS will not apply take prohibitions to scientific research activities that have received written approval from NMFS' Northwest or Southwest Regional Administrator.

Limit No. 8 – Habitat Restoration Limits on the Take Prohibitions

Habitat restoration activities are likely to help conserve listed fish without incurring significant risks, and NMFS concludes it is not necessary and advisable to impose take prohibitions on those activities provided the activity is part of a watershed conservation plan. NMFS considers a "habitat restoration activity" to be an activity whose primary purpose is to restore natural aquatic or riparian habitat processes or conditions; it is an activity that would not be undertaken but for its restoration purpose. Projects planned and carried out based on at least a watershed-scale analysis and conservation plan and, where practicable, a sub-basin or basin-scale analysis and plan, are likely to be the most beneficial. NMFS strongly encourages those involved in watershed restoration to conduct assessments that identify the factors impairing watershed function, and to plan watershed restoration and conservation activities based on those assessments. Without the overview a watershed-level approach provides, habitat efforts are likely to focus on "fixes" that may prove short-lived (or even detrimental) because the underlying processes causing a particular problem may not be addressed.

The final rule provides that take prohibitions will not apply to habitat restoration activities found to be part of, and conducted pursuant to, a watershed conservation plan that the state of Washington, Oregon, Idaho, or California has certified to be consistent with the state's watershed conservation plan guidelines. The state in which the activity occurs must certify in writing whether a watershed plan has been formulated in accordance with NMFS-approved state watershed conservation plan guidelines. NMFS will periodically review state Watershed Conservation Plan certifications to ensure that the Plans adhere to approved watershed conservation plan guidelines.

For this limit to apply, NMFS must find that the state's watershed conservation plan guidelines generate plans that: (1) Take into account the proposed activities' potential direct, indirect, and cumulative impacts in terms of their effect on listed species and populations; (2) will not reduce the likelihood of either survival or recovery of listed species in the wild; (3) ensure that any taking will be incidental; (4) minimize and mitigate any adverse impacts; (5) put in place effective monitoring and adaptive management programs; (6) use the best available science and technology, including watershed analysis; (7) provide for public and scientific review and input; (8) include any measures that NMFS determines are necessary or appropriate; (9) include provisions that clearly identify those activities that are part of plan implementation; and (10) control risk to listed species by ensuring that the plan components are funded and implemented.

Before approving watershed conservation plan guidelines, NMFS will publish notification in the Federal Register announcing the availability of the proposed guidelines for public review and comment. Such an announcement will provide for a comment period of no less than 30 days.

The proposed 4(d) rules identified interim provisions for habitat restoration activity categories to which the take prohibitions would not be applied for two years while watershed conservation plans were being developed. Based on the misunderstandings generated by that proposal, the interim provisions were dropped from the final rule.

NMFS strongly encourages jurisdictions, entities, and citizens to use the habitat restoration guidelines and technical manuals listed below as readily available techniques to reduce the risks of harming or injuring the listed stocks.

Applicable state guidance includes:

- *Oregon Road/Stream Crossing Restoration Guide*, Spring 1999, selected portions of *the Oregon Aquatic Habitat Restoration and Enhancement Guide* (1999);
- Oregon Department of Forestry and Department of Fish and Wildlife's *A Guide to Placing Large Wood in Streams*, May 1995;
- Washington Department of Fish and Wildlife, (WDFW) Habitat and Lands Environmental Engineering Division's *Fish Passage Design at Road Culverts*, March 3, 1999;
- Washington Administrative Code rules for Hydraulic Project Approval; and Washington's *Integrated Streambank Protection Guidelines*, June, 1998;
- California's *Stream Corridor Restoration, Principles, Processes and Practices* by the Federal Interagency Stream Restoration Working Group, October, 1998; and,
- *California Salmonid Stream Habitat Restoration Manual*, January, 1998.

These documents are available through the NMFS web page or directly from the relevant agencies.

Limit No. 9 – Water Diversion Screening

Operating water diversions without adequate screening is a widely recognized cause of mortality among salmon and steelhead. Juveniles may be sucked or attracted into diversion ditches where they later die from a variety of causes, including stranding. Adult and juvenile migration may be blocked by diversion structures such as push-up dams. Juveniles are often injured and killed when caught in pumping facilities or forced against screens.

State laws and Federal programs have long recognized these problems in varying ways, and encouraged or required adequate screening of diversion ditches and structures. Nonetheless, large numbers of diversions are not adequately screened and remain a threat, particularly to juvenile fish. Eliminating that source of injury or death is vital to conserving listed stocks.

The final rule encourages all diverters to move quickly to provide adequate screening or other protections for their diversions. The rule does not apply take prohibitions provided that NMFS' engineering staff—or any resource agency or tribal representative NMFS designates as an authorized officer—has agreed in writing that the diversion facility is screened, maintained, and operated in compliance with NMFS' Juvenile Fish Screening Criteria (NMFS 1996) or, in California, in compliance with NMFS Southwest Region's Fish Screening Criteria for Anadromous Salmonids (NMFS 1997) or any subsequent revision. If a diversion is screened, operated, and maintained in a manner consistent with those criteria, adequate safeguards will be in place and no additional Federal protection is necessary or advisable for conserving listed fish.

The final rule also provides that NMFS or its authorized officer may review and approve for a take limit a proposed juvenile fish screen design and construction plan. The plan must describe interim operation measures that will avoid taking threatened fish.

Limit No. 10 – Routine Road Maintenance

NMFS does not find it necessary or advisable to apply take prohibitions to routine road maintenance activities provided that: (1) The activity constitutes routine road maintenance conducted by Oregon Department of Transportation (ODOT) employees or agents that complies with ODOT's *Transportation Maintenance Management System Water Quality and Habitat Guide* (July, 1999); or (2) it is conducted by employees or agents of a state, county, city, or port under a program that complies substantially with that contained in the ODOT Guide and has been determined to meet or exceed the protections provided by the ODOT Guide; or (3) by employees or agents of a state, county, city, or port that complies with a routine road maintenance program that maintains or attains proper functioning condition (PFC).

The ODOT's maintenance and environmental staff have worked with NMFS in developing a routine road maintenance program that works well within the mandates of the ESA and the Clean Water Act, while carrying out the agency's fundamental mission to provide a safe and effective transportation system. That work has resulted in a program that greatly improves protections for listed fish that might be affected by a range of routine maintenance activities by minimizing the activities' impacts on streams.

For a state, city, county or port program that is equivalent to the ODOT program (or any of its amendments) to receive a limit it must get written approval from the NMFS Northwest or Southwest Regional Administrator, whichever is appropriate. Any jurisdiction desiring its routine road maintenance activities to be within this limit must first commit in writing to apply management practices that provide protection equivalent to or better than those provided by the ODOT Guide.

Limit No. 11 – Portland Parks Integrated Pest Management

The City of Portland, Oregon, Parks and Recreation Department (PP&R) operates a diverse system of city parks representing a full spectrum of urban habitat from intensively managed recreation, sport, golf, and garden sites to largely natural, unmanaged parks, including the several thousand acre, wooded, Forest Park. The PP&R has been operating and refining an integrated pest management program for 10 years, with a goal of reducing its use of pesticides. The program's "decision tree" places first priority on preventing pests (weeds, insects, disease) through policy, planning, and avoidance measures (design and plant selection). Cultural and mechanical practices, trapping, and biological controls form the second priority. The use of biological products and, finally, chemical products, is to be considered last. The overall program affects only a small proportion of the land base and waterways in Portland, and serves to minimize any impacts on listed fish from chemical applications associated with that specific, limited land base. NMFS believes it would help conserve listed fish if jurisdictions would broadly adopt a similar approach to eliminating and limiting chemical use in their parks and in other areas.

After carefully analyzing PP&R's integrated program for pest management, NMFS concludes that it addresses potential impacts and provides adequate protection for listed fish with respect to the limited use the program may make of the listed chemicals. NMFS does not find it necessary or advisable to apply additional Federal protections in the form of take prohibitions to PP&R activities conducted under the Pest Management Program. Take prohibitions would not meaningfully increase the level of protection the listed fish receive.

Confining the limit on take prohibitions to a specified list of chemicals does not mean NMFS has determined that other chemicals PP&R employs will necessarily harm salmon and steelhead. NMFS intends to continue working with PP&R on the use of any other herbicide or pesticide.

The PP&R program includes a variety of monitoring commitments and a yearly assessment schedule. If, at any time, monitoring information, new scientific studies, or new techniques cause PP&R to amend its program or if PP&R and NMFS wish to change the list of chemicals receiving limits on take prohibitions, PP&R must provide NMFS with a copy of the proposed change(s) for review. NMFS will publish notification in the *Federal Register* requesting public comment on the proposed changes. The comment period will be no less than 30 days; at its conclusion, NMFS will make a final determination on whether the changes will conserve listed salmon and steelhead.

Limit No. 12 – Municipal, Residential, Commercial and Industrial Development and Redevelopment (MRCI)

As a general matter, MRCI development (and redevelopment) have a significant potential to degrade habitat and injure or kill salmon and steelhead in a variety of ways. With appropriate safeguards, MRCI development can be specifically tailored to minimize impacts on listed fish to the extent that additional Federal protections would not be needed to conserve the listed ESU. Through the final rule, NMFS identifies a mechanism whereby cities, counties, and regional governments can ensure that MRCI development and redevelopment authorized within those areas are consistent with ESA requirements. Developers and their authorizing jurisdictions alike would benefit from the assurance that their actions conserve listed salmon and steelhead.

One example of an authorizing entity working toward the sort of plan envisioned in this limit is found in the fact that urban development in the Portland, Oregon metropolitan area may not occur outside of an adopted urban growth boundary (UGB). Metro, the regional governing body, is in the process of bringing some large areas currently designated as urban reserve areas into the UGB. Before development may commence in these newly included areas, the jurisdiction within which the area lies must prepare and adopt comprehensive plan amendments for urban reserve areas consistent with all provisions of the Metro Urban Growth Management Functional Plan. The amendments must show what development will be allowed and the conditions to be placed upon development.

NMFS will not apply take prohibitions to (1) MRCI development or redevelopment governed by and conducted in accordance with city, county, or regional government ordinances or plans that NMFS has found to adequately protect listed species; or (2) once NMFS has determined that Metro's Functional Plan is adequately protective, activities conducted under Metro's jurisdiction that are pursuant to ordinances that Metro has found comply with its Urban Growth Management Functional Plan. NMFS must agree in writing that the MRCI development ordinances and plans, including the Functional Plan, ensure that the plans and the development activities complying with them will conserve listed salmon and steelhead. NMFS will individually apply the following 12 evaluation considerations when determining whether MRCI development ordinances or plans adequately conserve listed fish:

(1) An MRCI development ordinance or plan ensures that development will avoid inappropriate areas such as unstable slopes, wetlands, areas of high habitat value, and similarly constrained sites. Activities such as development, timber harvest, or other soil disturbance should be sited in appropriate areas—avoiding unstable slopes, wetlands, areas already in a proper functioning condition, areas that are more functional than neighboring sites, and areas with the potential to be fully restored. A description of particularly sensitive areas is included in the Fish and Forest Report cited elsewhere in this guidance. Those sites include but are not limited to soils perennially saturated from a headwall or a sideslope seep or spring, the permanent initiation point of perennial flow of a stream, an alluvial fan, and the intersection of two perennial streams.

(2) An MRCI development ordinance or plan adequately prevents stormwater discharge impacts on water quality and quantity and stream flow patterns in the watershed—including peak and base flows in perennial streams. Stormwater management programs

must require development activities to avoid impairing water quality and quantity. These activities must preserve or enhance stream flow patterns so they are as close as possible to the historic peak flows, base flows, durations, volumes, and velocities. This can be accomplished by reducing impervious surfaces and maintaining forest cover and natural soils. These conditions will, in turn, maintain essential habitat processes such as natural water infiltration rates, transpiration rates, stormwater run-off rates, sediment filtering, and provide hydrographic conditions that maintain and sustain aquatic life.

(3) An MRCI development ordinance or plan protects riparian areas well enough to attain or maintain PFC around all rivers, estuaries, streams, lakes, deepwater habitats, and intermittent streams. Compensatory mitigation is provided, where necessary, to offset unavoidable damage to PFC in riparian management areas. Activities should be quite limited in areas adjacent to all perennial and intermittent streams and waters supporting listed salmon and steelhead in order to avoid soil disturbance and maintain vegetated riparian corridors. The existence of native vegetation along stream corridors is a condition that can support essential habitat processes such as temperature control, bank stability, stream complexity over time, the filtering of pollutants, or contributions of large logs and other woody debris to a stream.

Limiting activities in riparian areas helps protect or restore the condition and quality of soil and ensure that a diversity of plants and trees of all ages is well-distributed across a riparian area. Such conditions on the landscape contribute to the natural succession of riparian forest trees and protect the water quality and flow conditions necessary to meet salmonid habitat needs downstream. In urban areas, the riparian areas often face the added challenge of intercepting large amounts of nutrients, pesticides and sediment so that they do not directly enter a stream.

NMFS' determinations are significantly influenced by science indicating that essential habitat functions are affected to varying (but significant) degrees by streamside activities conducted within a distance equal to the height of the tallest tree that can grow on that site (known as the site potential tree height). The distance is measured not from the stream itself, but from the edge of the area within which a stream naturally migrates back and forth over time (the channel migration zone).

When the scope of an activity includes modifying a riparian site that has existing, non-native vegetation, it may be important to restore native vegetation on the site in order to recover the essential habitat functions discussed above.

(4) An MRCI development ordinance or plan avoids stream crossings—whether by roads, utilities, or other linear development—wherever possible and, where crossings must be provided, minimize impacts. One method of minimizing stream crossings and their associated disturbances is to optimize transit opportunities to and within newly developing urban areas. A plan should consider whether potential stream crossings can be avoided by redesigning the access. Where a crossing is unavoidable, the plan or ordinance should minimize its affect by preferring bridges over culverts; sizing bridges to a minimum width; designing bridges and culverts to pass at least the 100-year flood (and associated debris), and meet Oregon Department of Fish and Wildlife or Washington Department of Fish and Wildlife criteria (*ODFW's Oregon Road/Stream Crossing Restoration Guide, Spring, 1999 and WDFW's Fish Passage Design at Road Culverts, March 3, 1999*). In addition, all crossings must be regularly monitored and maintained and intermittent and perennial streams should not be closed over.

(5) An MRCI development ordinance or plan adequately protects historic stream meander patterns and channel migration zones and avoids hardening stream banks and shorelines. Any MRCI development should be designed to allow streams to meander in historic patterns of channel migration. Activities on the landscape must protect conditions that allow gradual bank erosion, flooding, and channel meandering in the zone within which it would naturally occur. This natural channel migration promotes gravel recruitment, geomorphic diversity, and habitat development. If an adequate number of riparian

management areas are linked to the channel migration zone, there should be no need for bank erosion control in all but the most unusual situations. In most circumstances, activities that call for hardening stream banks are not consistent with PFC.

If unusual circumstances require bank erosion to be controlled, it should be accomplished through vegetation or carefully bioengineered solutions. Rip-rap blankets or similar hardening techniques would not be allowed, unless particular site constraints made bioengineered solutions impossible. NMFS finds that the Washington Department of Fish and Wildlife's publication, "*Integrated Streambank Protection Guidelines*" (June, 1998) can provide sound guidance, particularly regarding mitigation for gravel recruitment.

The Fish and Forest Report, cited elsewhere in this guidance, includes a detailed description of the types of channel migration zones found in most geomorphic settings. Further, the Washington State Forest Practices Board has published its *Standard Method for Measuring Physical Parameters of Streams and Channel Migration Zones (March, 2000).* Though it is designed for the forested environment, NMFS finds the document a useful aid in determining channel migration zones in any setting.

(6) An MRCI development ordinance or plan adequately protects wetlands, wetland buffers, and wetland function—including isolated wetlands. Activities on the landscape must protect wetlands and the vegetation surrounding them to avoid disturbing soils, vegetation, and local hydrology. Such conditions on the landscape contribute to the natural succession of wetlands, and protect wetland functions necessary to meet salmonid habitat needs such as food chain support, shoreline protection, water purification, storm and flood storage, and groundwater recharge. These conditions are also necessary to protect the freshwater, marine, and estuarine wetland systems that provide specialized habitat for rearing and migrating salmon and steelhead.

(7) An MRCI development ordinance or plan adequately preserves permanent and intermittent streams' ability to pass peak flows. Activities that decrease a stream's hydrologic capacity by filling in its channel for road crossings or other development will increase water velocities, flood potential, and channel erosion, as well as degrade water quality, disturb soils, and groundwater flows, and harm vegetation adjacent to the stream. Preserving hydrologic capacity will provide conditions on the landscape necessary for maintaining essential habitat processes such as water quantity and quality, streambank and channel stability, groundwater flows, and succession of riparian vegetation. In combination with the riparian management areas or set-back provisions described above, this means that dredge and fill should be avoided unless they are conducted in conjunction with a necessary stream crossing whose impacts are mitigated to the greatest extent possible.

(8) An MRCI development ordinance or plan stresses landscaping with native vegetation to reduce the need to water and apply herbicides, pesticides, and fertilizer. Plans must describe the techniques local governments will use to encourage planting with native vegetation, reducing lawn area, and lowering water use. These provisions will maintain essential habitat processes by helping conserve water and reduce flow demands that compete with fish needs. They will also reduce applications of chemicals that contribute to water pollution in streams and other water bodies supporting salmon and steelhead.

(9) An MRCI development ordinance or plan contains provisions to prevent erosion and sediment run-off during (and after) construction and thus prevent sediment and pollutant discharge to streams, wetlands and other water bodies that support listed fish. These provisions, at a minimum, should include detaining flows, stabilizing soils, protecting slopes, stabilizing channels and outlets, protecting drain inlets, maintaining best management practices (BMPs), and controlling pollutants. These goals can be accomplished by applying seasonal work limits, phasing land clearing activities, maintaining undisturbed native top soil and vegetation, etc.

These stipulations will help maintain natural runoff rates and protect water quality.

(10) An MRCI development ordinance or plan ensures that demands on the water supply can be met without affecting—either directly or through groundwater withdrawals—the flows salmon need. A plan must ensure that any new water diversions are positioned and screened in a way that does not injure or kill fish.

(11) An MRCI development ordinance or plan provides mechanisms for monitoring, enforcing, funding, reporting, and implementing its program. Moreover, formal plan evaluations should take place at least once every five years. The plan should make a commitment to (and assign responsibility for) regular monitoring and maintenance activities for any detention basins, erosion and sediment control measures, and other management tools over the long term. Practices should be adopted as needed based on monitoring results. In addition, to ensure that development activities comply with the ordinance or plan and that PFC is attained or maintained, commitments must be made for regular funding, enforcement, reporting, implementation, and plan evaluations. These commitments are necessary to lead to conditions that will maintain the whole suite of essential habitat processes for salmon and steelhead.

(12) An MRCI development ordinance or plan complies with all other state and Federal environmental and natural resource laws and permits.

NMFS concludes that development governed by ordinances or plans that fulfill the listed considerations will address the potential negative impacts on salmon and steelhead associated with development and redevelopment. In such circumstances adequate safeguards will be in place that NMFS does not find it necessary or advisable to impose additional Federal protections through the take prohibitions.

Limit No. 13 – Forest Management in Washington

In the State of Washington, NMFS has worked with timber industry representatives, tribes, state and Federal agencies, and various interest groups for many months. The purpose of these discussions was to develop a set of forest practices that could be included in Washington Governor Locke's salmon recovery plan. The product of those discussions is the April 29, 1999, Forests and Fish Report (FFR) to Governor Locke. It provides important improvements in forest practice regulation which, if approved by the Washington Forest Practices Board in a form at least as protective as it is laid out in the FFR, will substantially protect and conserve listed fish in that state. The FFR also mandates that all existing forest roads be inventoried for their potential to affect salmon and steelhead and that all needed improvements be completed within 15 years. The impacts that inadequately sited, constructed, or maintained forest roads have on salmonid habitat are well-documented. This feature alone will help a great deal in conserving listed ESUs in Washington.

After carefully considering the above features—as well as others described in greater detail below—NMFS has determined it is not necessary to apply take prohibitions to non-Federal forest management activities conducted in the State of Washington. These activities may go forward provided that: (1) The action complies with forest practice regulations the Washington Forest Practices Board has adopted and implemented and that NMFS has found to protect habitat functions at least as well as the regulatory elements of the FFR; and (2) the activity also implements all non-regulatory elements of the FFR. It should also be noted that actions taken under alternative plans may be included under this limit provided the Washington Department of Natural Resources (WDNR) finds the alternate plans protect physical and biological processes at least as well as the state forest practices rules and that NMFS, or any resource agency or tribe NMFS designates, has the opportunity to review each alternate plan at every stage of its development and implementation. Given these conditions, NMFS concludes that the FFR package conserves salmon and their habitat well enough that it is neither necessary nor advisable to impose take prohibitions.

NMFS believes that to conserve listed fish, it is important to rapidly adopt and implement improved forest practice regulations such as those found in the FFR. NMFS will provide an opportunity for the public to review and comment on all regulations developed to implement the FFR before making any determinations about how well they conserve listed fish.

Although NMFS will continue working with Washington (and other states) on broadening this limit, at this time NMFS lacks information to determine that pesticide provisions in the FFR package, sufficiently protect and conserve listed fish. Therefore, this limit does not extend to the use of herbicides, pesticides, or fungicides.

Elements of the FFR that protect and conserve listed salmon and steelhead are summarized below:

(1) It accurately classifies water bodies and makes stream typing information broadly available. It is tailored to protect and reinforce the functions and roles of different stream classes in the continuum of the aquatic ecosystem. These include fish-bearing streams—which may have either perennial or seasonal flow; perennial, non-fish-bearing streams—which include spatially intermittent streams; and seasonal, non-fish-bearing streams—which have a defined channel that contains flow at some time during the year.

(2) It lays out a plan for properly designing, maintaining, and upgrading existing and new forest roads. As stated previously, this is an important means of maintaining and improving water quality and instream habitats. The FFR provisions address: Road construction and reconstruction in riparian areas and on potentially unstable slopes; the potential for new and reconstructed roads to affect hydrologic connections between stream channels, ground water, and wetlands, and to add sediment to aquatic systems; the ability for road structures (e.g., culverts and bridges) to pass fish, 100-year flows, and instream debris; a plan to assess (within 5 years) the condition of all forest roads and to determine the need to repair, reconstruct, maintain, control access, abandon or obliterate them with work to be completed within 15 years; and BMPs for all other aspects of forest road operation.

(3) It protects unstable slopes from increased failure rates and volume.

(4) It allows properly functioning condition to be achieved in riparian areas along fish-bearing waters. Proper function refers to the suite of riparian and instream functions that affect both instream habitat conditions and the vigor and succession of riparian forest ecosystems. The functions include stream bank stability, shade, litterfall and nutrient input, large woody debris recruitment, and microclimate factors such as air and soil temperature, windspeed, and relative humidity. The FFR ensures properly functioning condition by establishing variable-width management zones within which silvicultural treatments are allowed. These treatments are prescribed through forestry guidelines that NMFS has determined will set a riparian forest stand on a growth and succession pathway toward a desired future condition (DFC) of a mature riparian forest. Once the stand is on the proper trajectory toward DFC, it must remain there without further harvest or silvicultural treatment. Riparian management includes the following provisions:

- Continuous riparian management zones along all fish-bearing streams.
- A core zone at least 50 ft (15 m) wide west of the Cascades and 30 ft (9 m) on the east side, within which no harvest or salvage occurs. This width is measured horizontally from edge of the bankfull channel, or where channel migration occurs, from the outer edge of the channel migration zone.
- An inner zone that varies in width depending on the timber harvest strategy.
- An outer zone extending to a site tree height (100 year base) that provides a

minimum of 20 conifer trees per acre that are greater than 12 inches (0.30m) in diameter at breast height.

- Overstory canopy disturbance along a stream is limited to 20% for roads and yarding corridors and ground disturbance is limited to 10%.
- A mature riparian forest is the DFC. Generally, mature riparian forest conditions are achieved after 80 to 200 years. Once this DFC trajectory has been achieved the riparian stand will be allowed to grow without further harvest or treatment.
- A method for applying riparian prescriptions in the field so that DFC will be achieved.
- Riparian conservation zone widths that provide bank stability, litterfall and nutrients, shade, large woody debris, sediment filtering, and microclimate functions in the near and long-term.
- Mitigation for the effects permanent road systems near stream channels have on riparian function, water quality, and fluvial (floodplain) processes.
- Treatment guidelines—by tree species, stand age and condition, and region—that address stocking levels, tree selection, spacing, and other common forest metrics needed to achieve DFC.
- Guidelines for converting certain hardwood-dominated riparian areas to forest stands that can achieve the pathway toward DFC.
- A strategy for conserving fluvial processes and fish habitats in the channel migration zone.
- Guidelines for salvaging dead or downed timber in the inner and outer riparian zones.
- Provisions for managing riparian areas along perennial and seasonal non-fish-bearing streams to achieve a large measure of riparian function.

(5) It sets up a process for evaluating the effects of multiple forest practices on the watershed scale.

(6) It ensures that any alternative plan would provide a functionally equivalent level of conservation.

(7) It includes a monitoring and adaptive management process that managers will use to determine how well the practices are being implemented, how well they comply with regulation, and how effective the regulations themselves are to assess implementation compliance with, and effectiveness of, current regulations, measured against a baseline data set. Over time, some forest practices will likely need to be replaced or adjusted as new information comes in. Whenever new information leads the state forest practice agency to amend a program under this limit, NMFS will publish a notification in the *Federal Register* announcing the availability of those changes for review and comment. Such a notice will provide for a comment period of not less than 30 days, after which NMFS will make a final determination on how well the changes conserve listed fish and thus whether they may be included under this limit on the take prohibitions.

Regular Evaluation of Limits on Take Prohibitions

In determining that it is neither necessary nor advisable to impose take prohibitions on certain programs or activities described in the final rule, NMFS is mindful that new information may require that conclusion to be reevaluated at some future point. NMFS will evaluate all of the limits on the take prohibitions described in the final rule on a regular basis to determine the program's effectiveness in protecting and conserving the listed fish. If the program is not sufficiently protective, NMFS will identify ways in which it needs to be altered or strengthened. Changes may be identified if the program does not protect desired habitat functions or, even if the program supports the originally targeted habitat characteristics and functions, the habitat does not uphold population productivity levels needed to conserve the ESU.

If any jurisdiction conducting activities that fall under a given limit does not make changes to respond adequately to the new information in the shortest amount of time feasible—and in no case taking more than one year—NMFS will publish notification in the Federal Register announcing its intention to withdraw the limit and apply the take prohibitions to the program. Such an announcement would provide a comment period of at least 30 days, after which NMFS would make a final determination whether to subject the activities to the ESA section 9(a)(1) take prohibitions.

Other ESA Mechanisms

Section 10 of the ESA provides another mechanism for NMFS to permit take when it is the incidental result of carrying out an otherwise lawful activity. Applicants for an Incidental Take Permit must submit a Conservation Plan (CP) that identifies (a) the impacts expected from any take associated with activities covered by the plan, and (b) the steps that will be taken to monitor, minimize, and mitigate those impacts. For more information on CPs, see the publication entitled "*A Habitat Conservation Plans and the Incidental Take Permitting Process*," available on the U.S. Fish and Wildlife Service web site, at http://www.fws.gov/r9endspp/hcp/hcpplan.html, or speak with one of the NMFS contact people listed below.

Section 7 of the ESA requires that Federal agencies consult with NMFS on activities they authorize, fund, or carry out to ensure they are not likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of their critical habitat. This includes Federally funded projects such as road construction, stormwater management, rural and urban development, and many other activities conducted, permitted, or funded by Federal agencies.

How NMFS Decides What May Be Included In a 4(d) Rule Limit

Whether take prohibitions or other protective regulations are necessary and advisable depends largely upon the biological status of the species and the potential impacts of various activities on it. If programs contribute to conserving the species or adequately limit the impacts on the species, NMFS may find it is not necessary or advisable to impose the Federal take prohibitions. NMFS expects to continue to work with various entities after the final rule is published, and we will continue to incorporate other conservation efforts in future amendments or through other ESA mechanisms.

In assessing the impacts of a proposed action or program on a species= freshwater or estuarine habitat, NMFS considers the following factors:

- Will the action or program degrade existing habitat processes or functions?
- Will the action or program help restore degraded habitat processes or functions?

The limits in the current rule provide examples of how activities that may harm salmon and steelhead can be adequately controlled to minimize impacts and contribute to the conservation of salmon and steelhead.

All development activities need adequate funding and legal mechanisms for implementing, monitoring, maintenance, enforcement, and reporting in order to ensure that they comply with approved policies, ordinances, and permitting procedures. NMFS expects that programs proposed for a limit will be sufficiently described, guided, or governed by an applicable authority (other than just the ESA itself). These authorities could include state laws, county regulations, metropolitan master plans, local ordinances, official operating manuals, or other regulating mechanisms. In order to qualify for a limit, these mechanisms and the entities implementing them must provide a high degree of assurance that covered activities are being conducted in compliance with the specifications NMFS has analyzed and approved.

To be approved for a limit from ESA take prohibitions, a program must conserve salmon and meet their biological requirements. This criterion is the same for any program. These species span the entire West Coast, from coastal rainforests to arid inland areas to high mountain regions nearly a thousand miles from the ocean. Specific requirements will differ from place to place. Some jurisdictions have asked for NMFS' help in learning how to avoid or limit adverse impacts on these species. In response, we have created this Guide and amended the final rule to make clear what must be done to protect and conserve listed fish.

Submitting a Program for 4(d) Limit

Any activity or program seeking a limit under a 4(d) rule should contain the following features.

- Descriptions of the activity or program being proposed, the geographic area within which the proposed action/program will apply or be carried out, and the jurisdiction or entity responsible for overseeing the action/program.
- A description of the listed species and habitat that will be affected by the action. This information should include fish distribution and abundance in the affected area and a description of the type, quantity, and quality of habitat in the affected area.
- A description of the environmental baseline. This information should describe existing habitat conditions in terms of water quality, access, riparian areas, stream channels, flow, and watershed health indicators such as total impervious area and any existing high quality habitat areas.
- A description of the anticipated short-term and long-term impacts the action is expected to have on the species (including all life-cycle stages) and its habitat. This description should include both positive and negative impacts and describe how any adverse impacts will be avoided, mitigated, or minimized.
- A discussion of the likelihood that the program or action will be implemented as described. Some questions that would need to be answered are: What commitment has been made to carry out the action or program? Are the legal authorities needed to carry out the program in place? Is implementation funding available and adequate? Is staffing available and adequate? What is the schedule for implementation? If the program is currently being implemented, what is its record of implementation and effectiveness to date?
- A program for monitoring both the action's implementation and effectiveness; it should include a schedule for conducting monitoring and submitting reports.
- A method for using monitoring information to change actions when needed—adaptive management.

Contact Information

The table below identifies the appropriate division and individual staff member at NMFS to contact regarding inquiries about initiating the process to receive a 4(d) limit or to identify other ESA permitting options:

TOPIC/TYPE OF ACTIVITY	NMFS DIVISION	FOR MORE INFORMATION
Ongoing Scientific Research Permit	Protected Resources	Leslie Schaeffer (503/230-5433)
Fishery Management	Sustainable Fisheries	http://www.nwr.noaa.gov/1fmep/index.html or Stephen Smith (503/230-5427) or Peter Dygert (206/526-6734)
Hatchery and Genetic Management Programs	Sustainable Fisheries	http://www.nwr.noaa.gov/1hgmp/hgmptmpl.htm or Stephen Smith (503/230-5427)
Scientific Research Conducted by States	Protected Resources	Leslie Schaeffer (503/230-5433)
Screened Water Diversions	Hydropower Program	http://www.nwr.noaa.gov/1hydroweb/ferc.htm or Bryan Nordlund (503/231-6816)
• Joint Tribal/State Plans • Routine Road Maintenance Activities • City of Portland Integrated Pest Management • Municipal, Residential, Commercial and Industrial Development (and Redevelopment) • Section 10 Incidental Take Permit • Section 7 Consultation	Habitat Conservation	**State of Washington** – Steve Landino (360/753-6054) **State of Oregon, but not including Snake River Basin** – Michael Tehan (503/231-2224) **State of Idaho, and the Snake River Watershed in Oregon** – Ted Meyers (208/378-5698) **State of California** – Craig Wingert (562/980-4021)

Additional Information on the Final 4(d) Rule

Please visit the NMFS Northwest Region Web Site at http://www.nwr.noaa.gov or the Southwest Region Web Site http://swr.ucsd.edu for additional information on the final 4(d) rule for salmon and steelhead. The sites contain the *Federal Register* notice, fact sheets, maps of threatened salmon and steelhead ESUs, press releases, copies of question and answer fact sheets, and documents referenced in the rule. The sites also contain a great deal of information on listed species in general: *Federal Register* notices, species maps, status reviews, fact sheets, and more. In addition, the following NMFS staff members can provide information on the final rule:

TOPIC/GEOGRAPHIC AREA	CONTACT
Final 4(d) Rule	Rosemary Furfey (503/231-2149) Rosemary.Furfey@noaa.gov
Puget Sound	Elizabeth Babcock (206/526-4505) Elizabeth.Babcock@noaa.gov
Upper Columbia Basin	Mike Grady (206/526-4645) Michael.Grady@noaa.gov
Mid-Columbia Basin	Kate Vandemoer (503/230-5422) Kate.Vandemoer@noaa.gov
Lower Columbia Basin	Rob Jones (503/230-5429) Rob.Jones@noaa.gov
Willamette Basin or Oregon Coast	Patty Dornbusch (503/230-5430) Patty.Dornbusch@noaa.gov
California Coast	Greg Bryant (707/825-5162) Greg.Bryant@noaa.gov

Effective Dates of Final 4(d) Rule

Species	Effective Date of 4(d) Rule
Threatened Steelhead ESUs	60 days after the final 4(d) rule is published
Threatened Salmon ESUs	180 days after the final 4(d) rule is published

Finding Your Way Around the 4(d) Rule

The proposed 4(d) rule included a preamble in which NMFS provided technical guidance, descriptions of the scientific principles upon which the limits were based, and descriptions of the limits' background and content. The proposed regulatory language was in a separate Code of Federal Regulation (CFR) section.

The final 4(d) rule for salmon and steelhead is divided into two sections—the preamble and the CFR language. The preamble includes the following sections:

- A summary of the final rule and its effective dates
- Supplementary Information—including the rule's background and a description of its content
- A list of the threatened ESUs affected by the final rule
- Notice of availability of documents referenced in the final rule
- A summary of the comments received in response to the proposed rules
- A section identifying the changes to the proposed 4(d) rule made in response to public comment
- Take Guidance
- A section detailing how the rule complies with the Regulatory Flexibility Act and various Executive Orders

The last section of the final rule includes the regulatory language that applies the section 9 take prohibitions to the 14 threatened ESUs listed below and creates 13 limits on those prohibitions. The regulations section describes each limit.

The following is a list of the 14 threatened ESUs covered in the final 4(d) rule:

Threatened Steelhead ESUs
- Central California Coast
- South-Central California Coast
- Snake River Basin
- Lower Columbia River
- Central Valley, California
- Upper Willamette River
- Middle Columbia River

Threatened Chum ESUs
- Hood Canal summer-run
- Columbia River

Threatened Chinook ESUs
- Puget Sound
- Lower Columbia River
- Upper Willamette River

Threatened Cobo ESUs
- Oregon Coast

Threatened Sockeye ESUs
- Ozette Lake

Technical Issues: Aids for Understanding the 13 Limits in the 4(d) Rule

Viable Salmonid Populations

NMFS uses the Viable Salmonid Population (VSP) concept primarily in evaluating hatchery and harvest activities. NMFS defines populations following Ricker's (1972) definition of a "stock." Thus, a population is a group of fish of the same species spawning in a particular lake or stream (or portion thereof) at a particular season which to a substantial degree does not interbreed with fish from any other group spawning in a different place or in the same place at a different season. This definition is widely accepted and applied in the field of fishery management.

An independent population is an aggregation of one or more local breeding units that are closely linked by exchange of individuals among themselves, but are sufficiently isolated from other independent populations that exchanges of individuals among populations do not appreciably affect the population dynamics or extinction risk of the populations over a 100-year time frame. Such populations are generally smaller than their entire ESU, and they generally inhabit geographic ranges on the scale of whole river basins or major sub-basins that are relatively free of outside migration. For several reasons, NMFS believes it important to identify population units within established ESUs and individually evaluate their extinction risk. First, many of the biological processes that can drive a species to extinction operate at the population level, so it is appropriate to manage at that scale. In addition, by identifying and assessing impacts at the population level, managers can gain a better understanding of the important biological diversity contained within each ESU—a factor considered in NMFS' ESU policy (Waples 1991). Further, given an ESU's scale and complexity, it is typically a more practical undertaking to assess impacts at the population level. Finally, assessing impacts at the population level helps ensure that listed salmon and steelhead are treated consistently across a diverse geographic and jurisdictional range.

NMFS will use four primary biological parameters to evaluate population status: (1) Abundance, (2) population growth rate, (3) population spatial structure, and (4) diversity. The relevance of these parameters to salmonid population status is discussed in a variety of scientific documents (e.g., Nehlsen et al. 1991; Burgman et al. 1993; Huntington et al. 1996; Caughley and Gunn 1996; Myers et al.,1998). Population abundance is important to evaluate because smaller populations experience relatively greater genetic, environmental, and demographic risks. Genetic risks associated with low population size include inbreeding depression, harmful mutation accumulation, and loss of genetic diversity. Demographic risks associated with low population size include random effects associated with environmental events.

Population productivity may be thought of as the population's ability to increase or maintain its abundance. It is important to assess productivity because negative trends in productivity over sustained periods may lead to the genetic and demographic impacts associated with small population sizes. Population spatial structure reflects the number, size, and distribution of habitat patches and the condition of the migration corridors that provide linkages among these patches. Population structure affects demographic processes and extinction risk in ways that may not be readily apparent from studies of abundance and population growth rate. In addition, spatial structure affects evolutionary processes and may affect a population's ability to respond to environmental changes or stochastic events.

Population diversity is important because it helps buffer a species against short-term environmental change and stochastic events. Population diversity may be assessed by examining life history traits such as age, and run and spawn timing distributions. Also, DNA analysis may provide an indication of diversity.

In applying the concepts discussed here to harvest and hatchery actions, NMFS relies on two functional thresholds of population status: (1) Critical population threshold, and (2) viable population threshold. The critical population threshold refers to a minimal functional level below which a population's risk of extinction increases exponentially in response to any additional genetic or demographic risks. The viable population threshold refers to a condition where the population is self-sustaining and not at risk of becoming endangered in the foreseeable future. This threshold reflects the desired condition for individual populations and encompasses their contribution to recovering the ESU as a whole. Proposed actions must not preclude populations from attaining this condition.

Properly Functioning Condition

The final rule limits the take prohibitions for certain land and water management activities that NMFS has determined will conserve listed salmonids' habitat even though they may incidentally take individual listed fish. To make these determinations, NMFS evaluated whether the activities would allow properly functioning habitat condition to be attained and persist. The NMFS defines properly functioning condition (PFC) as the sustained presence of natural habitat-forming processes (e.g., hydraulic runoff, bedload transport, channel migration, riparian vegetation succession) that are necessary for the long-term survival and recovery of the species (*The Habitat Approach*, NMFS, 1999). Thus, PFC constitutes a species' habitat-based biological requirements—the essential physical features that support spawning, incubation, rearing, feeding, sheltering, migration, and other behaviors. Such features include adequate instream flow, appropriate water temperature, loose gravel for spawning, unimpeded fish passage, deep pools, and abundant large tree trunks and root wads.

There is more than one scientifically credible analytical framework for determining an activity's effects. However, NMFS has developed a default analytical method (*Making Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Watershed Scale*, NMFS, 1996). It is often referred to as the "Matrix of Pathways and Indicators," or MPI. In the MPI framework, the pathways for determining the effect of an action are represented as six conceptual groupings (e.g., water quality, channel condition) of 18 habitat condition indicators (e.g., temperature, width/depth ratio). Indicator criteria (mostly numeric, though some are narrative) are provided for three levels of environmental baseline condition: properly functioning, at risk, and not properly functioning. The effect of the action upon each indicator is classified by whether it will restore, maintain, or degrade the indicator.

Although the indicators used to assess habitat condition may entail instantaneous measurements, they are chosen, using the best available science, to detect the health of underlying processes, not static characteristics. "Best available science" advances through time, thus allowing PFC indicators to be refined, new threats to be assessed, and species status and trends to be better understood. Aquatic habitats are inherently dynamic, and the PFC concept recognizes that natural patterns of habitat disturbance will continue to occur. Floods, landslides, windstorms, and fires result in spatial and temporal variability in habitat characteristics, as do human activities. Indicators of PFC vary between different landscapes based on unique physiographic and geologic features. For example, aquatic habitats on timberlands in glacial mountain valleys are controlled by natural processes operating at different scales and rates than are habitats on low-elevation coastal rivers. The MPI provides a consistent but geographically adaptable framework for making effect determinations. The pathways and indicators, as well as the ranges of their associated criteria, are amenable to alteration through the process of watershed analysis.

Regardless of the analytical method used, if a proposed action is likely to impair properly functioning habitat, appreciably reduce the functioning of already impaired habitat, or retard the long-term progress of impaired habitat toward PFC, it cannot be found to be consistent with the conservation of the species. If a program preserves existing habitat function levels and allows natural progression towards PFC where habitat is impaired, NMFS may determine that it qualifies for a limit on the take prohibitions. The NMFS has added language to the limits for road maintenance, pesticide management, municipal, residential, commercial and industrial (MRCI) development, and forestry that defines PFC and identifies how NMFS will evaluate programs with regard to meeting this biological standard. Specific criteria for applying this conservation standard are listed in each habitat-related limit.

The scope of any given activity is important to NMFS' effects analysis. The scope of the activity may be such that only a portion of the habitat forming processes in a watershed are affected by it. For NMFS to find that an activity is consistent with conserving listed fish, only the effects on habitat functions that are within the scope of that activity will be evaluated. For example, an integrated pest management program may affect habitat forming processes related to clean water, but have no effect on physical barriers that prevent fish from gaining access to a stream.

Jeffrey B. Litwak
Counsel
Columbia River Gorge Commission
288 E. Jewett Blvd.
P.O. Box 730
White Salmon, WA 98672
(509) 493-3323

NOTE: This short essay briefly introduces the issues that I will raise for discussion by the ESA panel.

CONSISTENCY, A NEW APPROACH FOR NMFS (LOTS OF QUESTIONS, FEW ANSWERS)

I. INTRODUCTION

On June 20, 2000, the National Marine Fisheries Service announced the final rules (4(d) rules) for protection of 14 ESUs (evolutionary significant units) of salmon and steelhead in Oregon, Washington, Idaho, and California. The rules, codified at 50 C.F.R. § 223.203, were published on July 10, 2000. 65 Fed. Reg. 42422 (July 10, 2000). The rules implement the ESA's prohibition on taking threatened or endangered species without a permit. 16 U.S.C. § 1538(1)(b).

The ESA defines "take" as "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or attempt to engage in such conduct." 16 U.S.C. § 1532(19). "Harm" includes "significant habitat modification or degradation where it actually kills or injures protected species by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering." 50 C.F.R. § 17.3.

The 4(d) rules for protection of salmon and steelhead represent a new approach to regulating habitat modification. In these rules, NMFS permits state, regional, and local governments to submit their plans, ordinances, and programs for review by NMFS. If NMFS deems the submittal adequate (I.e., consistent with specific provisions of the rules), then activities that are fully covered by the limits are thus presumed to not harm the protected species and are thus exempt from the ESA's take permit requirement. There are 13 types of limits identified in the rules. Most land use regulations, development projects, and planning in general will fall into the "Municipal, Residential, Commercial, and Industrial Development and Redevelopment (MRCI)" limit.

II. CONSISTENCY—ITS ABOUT TIME

Local land use consistency with state land use requirements is a long-recognized concept in Oregon—and throughout the United States. Finally, NMFS has embraced consistency in its new 4(d) rules. Consistency has some obvious benefits for both regulators and project proponents.

A. Benefits for Project Proponents

The obvious benefit is the streamlining of permitting processes. Proponents will not need to seek section 9 take permits, nor be concerned that their activities will "take" or "harm" listed species.

B. Benefits for Regulators

Consistency also gives regulators a shield on liability—through the presumption of compliance with the ESA. Two cases that have been around a while held government regulators liable under the ESA: *Strahan v. Coxe*, 127 F.3d 155 (1st Cir. 1997) (Massachusetts liable under the ESA for licensing commercial fishing operations to use gillnets and lobster pots in specifically the manner that is likely to result in a violation of federal law.); *Loggerhead Turtle v. County Council of Volusia County*, 896 F. Supp. 1170, 1180-81 (M.D. Fla. 1995) (holding that county's authorization of vehicular beach access during turtle mating season exacted a taking of the turtles in violation of the ESA).

C. Issues with consistency programs

1. <u>Oversight and Enforcement</u>

Perhaps the most significant issue that arises with "consistency" is oversight and enforcement. We in Oregon are no strangers to this issue; we have DLCD. But this issue is not so ingrained elsewhere. My experience in the Columbia River Gorge National Scenic Area has shown that Oregon counties have generally accepted the Gorge Commission's oversight authority, but the Washington counties have been less accepting. The Salmon and Steelhead listings cover areas in Oregon, Washington, Idaho, and California. Can NMFS expect a high level of acceptance throughout the four-state region?

How will NMFS oversee and enforce the approved limits? Each of the limits has a specified process for NMFS to evaluate whether the programs approved under that limit are effective. For example, for the MCRI limits, the 4(d) rules specify that NMFS (1) will require annual monitoring reports from all programs that are deemed, (2) will review programs and as necessary suggest changes, and (3) if a program does not make the suggested changes, then NMFS will decide whether to withdraw the limit so that take prohibitions would apply to the program.50 C.F.R. § 223.203(b)(12)(iii). Is this the full extent of

NMFS' authority to ensure consistency? Can NMFS use the general ESA civil and criminal penalties? 16 U.S.C. § 1540.

2. Should the take prohibitions apply even if there is a limit in place?

Another issue is whether there are situations when the take prohibitions ought to apply even though the program has an approved limit. For example: Should the take prohibitions apply if the approved program results in a take not anticipated in its approved limit? Should the take prohibitions apply when a program acts beyond the scope of its approved limit?

III. NMFS' PROCESS FOR APPROVING LIMITS

NMFS does not have a specified process for how to submit a program, or for how it will review a program for approval of a 4(d) limit. However, the *Citizen's Guide to the 4(d) Rule for Threatened Salmon and Steelhead on the West Coast* (June 20, 2000) discusses the requirements for submitting a program. Those requirements include, inter alia:

> A description of the listed species and habitat that will be affected by the action. This information should include fish distribution and abundance in the affected area and a description of the type, quantity, and quality of habitat in the affected area.
>
> A description of the environmental baseline. This information should describe existing habitat conditions in terms of water quality, access, riparian areas, stream channels, flow, and watershed health indicators such as total impervious area and any existing high quality habitat areas.

Few governments have the resources to conduct such studies. More governments are better equipped to describe conditions on the land and monitor how activities approved under a program affect those conditions. Will NMFS be flexible with these requirements?

IV. CONCLUDING THOUGHT

Just how will this "Limit" concept work? It will no doubt be confusing for long time to come. There will be a patchwork of approved plans and programs—some plans will be adequate, others will not. Specific activities in adequate plans may not be exempt from the take prohibitions. No doubt, this changes the equation for due diligence in getting development approvals. It also changes the equation for whether regulators will give approvals.

Advising Clients in a 4(d)imensional World: Understanding the Parameters of Citizen Suits Under the Endangered Species Act

Richard H. Allan
Ball Janik LLP

Prepared for:
Oregon State Bar
Real Estate and Land Use Section Annual Meeting
August 11-12, 2000

Summary: The National Marine Fisheries Service (NMFS) has promulgated rules under Section 4(d) of the Endangered Species Act for "evolutionarily significant units" of salmon and steelhead listed as "threatened" under the Act.[1] The 4(d) rule for steelhead will take effect 60 days after publication in the *Federal Register*; the 4(d) rule for salmon will take effect 180 days after publication. When the rules take effect, they will prohibit "take" of threatened species, except under certain circumstances. In the final rules, NMFS indicates that it will consider approving "take" limitations for municipal, residential, commercial and industrial (MRCI) development and redevelopment conducted under ordinances or plans approved by NMFS as adequate to conserve listed salmon and steelhead. However, no such ordinances or plans will have been approved by NMFS before the steelhead 4(d) rule takes effect, and it is questionable whether any ordinances or plans will have been approved by NMFS before the salmon 4(d) rule takes effect.

The Section 4(d) rules provide a basis for federal enforcement actions and citizen suits against anyone believed to be violating the "take" prohibition. Therefore, where local zoning and development ordinances have not been approved as limitations under the 4(d) rules, Oregon real estate and land use attorneys must be prepared to advise their clients regarding the potential for enforcement actions and citizen suits under the Endangered Species Act.

I. THE SECTION 4(D) RULES: PROHIBITION ON "TAKE"

The 4(d) rules apply the same "take" prohibition to threatened salmon and steelhead runs as would otherwise apply to an endangered species under Section 9 of the ESA.

[1] The final rules had not been published in the *Federal Register* at the time this outline was prepared. The discussion of the final rules contained herein was based on "A Citizen's Guide to the 4(d) Rule for Threatened Salmon and Steelhead on the West Coast," National Marine Fisheries Service, June 20, 2000. The Citizen's Guide is available on the NMFS Northwest Region website: www.nwr.noaa.gov.

C. Notice Requirement

A citizen suit cannot be brought "prior to sixty days after written notice of the violation has been given to the Secretary, and to any alleged violator of any such provision or regulation." 16 U.S.C. § 1540(g)(2)(a)(i). The requirement is jurisdictional; the district court has no authority to excuse a failure to strictly comply with the notice requirement. Hallstrom v. Tillamook County, 493 U.S. 20, 26-28, 110 S. Ct. 304 (1989) (applying similar notice requirement under RCRA); Southwest Center for Biological Diversity v. U.S. Bureau of Reclamation, 143 F.3d 515, 520-21 (9th Cir. 1998). Even when it is clear that giving notice is a futile act (for example, because the alleged violator has stated that it will not alter its actions), a suit cannot be commenced until the end of the 60-day period. Lone Rock Timber Co. v. U.S. Dep't of Interior, 842 F. Supp. 433, 440 (D. Or. 1994).

D. When Must Suit Be Brought: Laches

As discussed above, a plaintiff cannot commence a citizen suit before the end of the 60-day notice period. However, there is no statute of limitations for an ESA citizen suit, i.e., no express "last day" that a citizen suit may be filed. Rather, the few courts to address the issue have applied the doctrine of laches. National Wildlife Fed'n v. Coleman, 400 F. Supp. 705 (S.D. Miss. 1975), *rev'd on other grounds*, 529 F.2d 359 (5th Cir. 1976), *cert. denied*, 97 S. Ct. 489. Under the doctrine of laches, a court may exercise its equitable discretion to deny injunctive relief to a plaintiff who has unreasonably delayed bringing an action, to the prejudice of the defendant. This is inherently a case-by-case, fact-based determination.

For real estate and land use practitioners, the clear import is that there is no bright line test to use when advising a client whether a citizen suit against a project is time barred.

E. Standards for Obtaining Injunctive Relief

1. Preliminary Injunction

The test in the Ninth Circuit for granting a preliminary injunction

> "is whether a party has demonstrated: (1) a likelihood of success on the merits and the possibility of irreparable injury; or (2) sufficiently serious questions going to the merits to make them a fair ground for litigation, and the balance of hardships tips sharply in favor of the party seeking relief." Marbled Murrelet v. Babbitt, 83 F.3d 1068, 1073 (9th Cir. 1996).

However, "Congress has determined that the balance of hardships always tips sharply in favor of endangered or threatened species." Marbeled Murrelet, 83 F.3d at 1073. The courts cannot use their ordinary equitable discretion to strike a different balance. Sierra Club v. Marsh, 816 F.2d 1376 (9th Cir. 1987). As a practical matter, therefore, plaintiffs will be able to obtain a preliminary injunction in an ESA citizen suit if they can show "sufficiently serious questions going to the merits to make them a fair ground for litigation."

2. Permanent Injunction

The Ninth Circuit "has repeatedly held than an imminent threat of future harm is sufficient for the issuance of an injunction under the ESA." Marbled Murrelet v. Babbitt, 83 F.3d 1060, 1064 (9^{th} Cir. 1996). The Ninth Circuit has rejected the argument that an injunction may not issue absent proof that the death or injury of a protected species has actually occurred. Marbled Murrelet, 83 F.3d at 1065.

In the context of the 4(d) rules for salmon and steelhead, this means that a citizen could obtain an injunction against development or redevelopment projects without having to show "dead fish," only an "imminent threat of future harm."

IV. ATTORNEY FEES

The ESA authorizes a court to award costs of litigation, including reasonable attorney and expert witness fees, in a citizen suit "whenever the court determines such award is appropriate."" 16 U.S.C. § 1540(g)(4). More than "some degree" of success on the merits is required before a plaintiff may recover fees:

> "An award is appropriate when a plaintiff has (1) prevailed on the merits and (2) contributed substantially to the goals of the Act in doing so." Oregon Natural Resource Council v. Turner, 863 F. Supp. 1277, 1285 (D. Or. 1994).

A plaintiff need not prevail on every claim asserted in order to be considered a prevailing party, and a plaintiff may be considered the prevailing party based on a settlement, stipulation, or consent judgment, if the suit clearly was a catalyst prompting the opposing party to take action. Sablan v. Department of Finance, 856 F.2d 1317 (9^{th} Cir. 1988); ONRC, 863 F. Supp. at 1281.

V. ACTIONS AGAINST STATE AND LOCAL GOVERNMENTS

It is possible that citizen suits will be brought against local governments that approve projects without having obtained approval from NMFS of a take limitation. Federal courts have held that a state or local government, pursuant to whose authority a private actor directly engages in a taking of endangered species, may be deemed to have violated the ESA:

- Strahan v. Coxe, 127 F.3d 155 (1st Cir. 1997), cert. denied, 119 S. Ct. 81, 119 S. Ct. 437 (1998) (upholding district court order in a citizen suit enjoining State of Massachusetts to apply for an incidental take permit and to "develop and prepare a proposal... to restrict, modify or eliminate the use of fixed-fishing gear in coastal waters of Massachusetts listed as critical habitat for Northern Right whales in order to minimize the likelihood additional whales will actually be harmed by such gear").

- Loggerhead Turtle v. Council of Volusia County, 148 F.3d 1231 (11th Cir. 1998) (holding that district court may fashion injunctive relief requiring County to address "take" of sea turtles caused by artificial beachfront lighting authorized by County ordinance).

- United States v. Town of Plymouth, 6 F. Supp. 2d 81 (D. Mass. 1998) (holding that U.S. Fish and Wildlife Service was entitled to preliminary injunction requiring town to prohibit off-road vehicles from certain beach areas to protect "threatened" piping plovers).

VI. SOME IMPLICATION OF THE 4(D) RULES AND ESA CITIZEN SUITS

- Limited "shields" against suits: In the near term, there are relatively few ways of shielding development projects against the potential for citizen suits. Local governments will not have ordinances approved by NMFS as "take" limitations before the steelhead 4(d) rule takes effect, and few if any are likely to have NMFS-approved limitation before the salmon 4(d) rules take effect. Thus, projects that do not have Section 10 incidental take permits or that have not undergone Section 7 consultation (for federally funded or permitted projects) are at least potentially targets for citizen suits. Thus ...

- Uncertainty is the rule: If you are representing clients in real estate development and redevelopment, a client may ask you whether a project is "safe" from attack by a citizen suit, particularly once all local approvals have been obtained. Your client (or a lender) may ask you for a legal opinion. Be careful: there are virtually no "bright line" tests for opining whether a project is "salmon safe" or whether it is too late for an opponent to file a citizen suit. Even if there were such tests, they would not necessarily prevent an opponent from filing a suit; they simply go to the merits of the suit.

- Distance is not a defense: Although much of the debate over the proposed 4(d) rules focused on measures to protect riparian areas (e.g., the "200-foot setback"), proximity of a project to fish-bearing rivers or streams is not a prerequisite for a citizen suit. For example, projects distant from streams, but that alter the quality, quantity, or timing of stormwater runoff, may "take" threatened species.

- Credible expert testimony: The fundamental issue in any ESA citizen suit against a development or redevelopment project is a scientific one: what is the project's potential to "take" threatened salmon or steelhead? The developers who will be best prepared to defend against citizen suits are those who develop their projects from the start based on sound science. Talk to reputable experts early in project design and document the measures taken to avoid impacts to threatened species.

- A 60-day notice is not the end of the world: If a client receives a 60-day notice of intent to file a citizen suit, do not simply use the time to prepare for litigation. Examine whether the alleged violations have any possible merit, and whether anything can be done to remedy potential violations before the 60-day period is over.

Citizen Suits vs. LUBA Appeals and Writs of Review: A Comparison[4]

	LUBA Appeal ORS 197.805 to 197.845	Writ of Review ORS 34.010 to 34.102	ESA Citizen Suit 16 U.S.C. § 1540(g)
Forum (exclusive jurisdiction)	Land Use Board of Appeals	State Circuit Court	U.S. District Court
Action Challenged	Final land use decision or limited land use decision	Decision or determination of "inferior court, officer, or tribunal," other than land use decision, limited land use decision, or expedited land division	Alleged violation of the statute or rules
Deadline for filing	Generally, 21 days after date decision sought to be reviewed becomes final	60 days from the date of the decision or determination sought to be reviewed	Cannot file within 60 days after written notice. Doctrine of laches can bar injunctive relief.
Standing: who may file	Anyone who appeared in the local proceeding orally or in writing	Any "party" to the local process or proceeding	"Any person"
Defendant or Respondent	Local government. Other persons may intervene.	Court, officer or tribunal whose decision is sought to be reviewed	Alleged violator. United States may intervene as a matter of right
Nature of Proceeding	Appellate hearing on the record.	Review of record or proceedings	Trial proceeding
Interim Relief	LUBA may grant stay under standards of ORS 197.845(1)	Circuit court may stay proceedings by defendant under ORS 34.070	Preliminary injunction
Relief Available	LUBA may affirm, remand or reverse local government decision.	Circuit court may affirm, modify, reverse or annul decision reviewed, and may award plaintiff restitution, if necessary	Permanent injunction
Attorney Fees	Yes, if party presents position "without probable cause." ORS 197.830(15)(b)	No provision	Yes, when court determines award of fees is appropriate

[4] This table does not include the procedures for review of an expedited land division. See ORS 197.360 to 197.380. It also does not address the procedures and timing for further appellate review of decisions rendered in each forum.

APPENDIX H
NPDES PHASE II STORMWATER PERMIT REGULATIONS

Federal Register Document

Related Material

- Other Related Documents

[Federal Register: December 8, 1999 (Volume 64, Number 235)]
[Rules and Regulations]
[Page 68721-68770]
From the Federal Register Online via GPO Access [wais.access.gpo.gov]
[DOCID:fr08de99-11]

[[Page 68721]]

Part II

Environmental Protection Agency

---

40 CFR Parts 9, 122, 123, and 124

National Pollutant Discharge Elimination System--Regulations for Revision of the Water Pollution Control Program Addressing Storm Water Discharges; Final Rule

Report to Congress on the Phase II Storm Water Regulations; Notice

[[Page 68722]]

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Parts 9, 122 , 123, and 124

[FRL--6470-8]
RIN 2040-AC82

National Pollutant Discharge Elimination System--Regulations for Revision of the Water Pollution Control Program Addressing Storm Water Discharges

AGENCY: Environmental Protection Agency (EPA).

ACTION: Final rule.

SUMMARY: Today's regulations (Phase II) expand the existing National Pollutant Discharge Elimination System (NPDES) storm water program (Phase I) to address storm water discharges from small municipal separate storm sewer systems (MS4s) (those serving less than 100,000 persons) and construction sites that disturb one to five acres. Although these sources are automatically designated by today's rule, the rule allows for the exclusion of certain sources from the national program based on a demonstration of the lack of impact on water quality, as well as the inclusion of others based on a higher likelihood of localized adverse impact on water quality. Today's regulations also exclude from the NPDES program storm water discharges from industrial facilities that have ``no exposure'' of industrial activities or materials to storm water. Finally, today's rule extends from August 7, 2001 until March 10, 2003 the deadline by which certain industrial facilities owned by small MS4s must obtain coverage under an NPDES permit. This rule establishes a cost-effective, flexible approach for reducing environmental harm by storm water discharges from many point sources of storm water that are currently unregulated.

EPA believes that the implementation of the six minimum measures identified for small MS4s should significantly reduce pollutants in urban storm water compared to existing levels in a cost-effective manner. Similarly, EPA believes that implementation of Best Management Practices (BMP) controls at small construction sites will also result in a significant reduction in pollutant discharges and an improvement in surface water quality. EPA believes this rule will result in monetized financial, recreational and health benefits, as well as benefits that EPA has been unable to monetize. Expected benefits include reduced scouring and erosion of streambeds, improved aesthetic quality of waters, reduced eutrophication of aquatic systems, benefit to wildlife and endangered and threatened species, tourism benefits, biodiversity benefits and reduced costs for siting reservoirs. In addition, the costs of industrial storm water controls will decrease due to the exclusion of storm water discharges from facilities where there is ``no exposure'' of storm water to industrial activities and materials.

DATES: This regulation is effective on February 7, 2000. The incorporation by reference of the rainfall erosivity factor publication listed in the rule is approved by the Director of the Federal Register as of February 7, 2000. For judicial review purposes, this final rule is promulgated as of 1:00 p.m. Eastern Standard Time, on December 22, 1999 as provided in 40 CFR 23.2.

ADDRESSES: The complete administrative record for the final rule and the ICR have been established under docket numbers W-97-12 (rule) and W-97-15 (ICR), and includes supporting documentation as well as printed, paper versions of electronic comments. Copies of information in the record are available upon request. A reasonable fee may be charged for copying. The record is available for inspection and copying from 9 a.m. to 4 p.m., Monday through Friday, excluding legal holidays, at the Water Docket, EPA, East Tower Basement, 401 M Street, SW, Washington, DC. For access to docket materials, please call 202/260-3027 to schedule an appointment.

FOR FURTHER INFORMATION CONTACT: George Utting, Office of Wastewater Management, Environmental Protection Agency, Mail Code 4203, 401 M

Street, SW, Washington, DC 20460; (202) 260-5816; sw2@epa.gov.

SUPPLEMENTARY INFORMATION: Entities potentially regulated by this action include:

Category	Examples of regulated entities
Federal, State, Tribal, and Local Governments.	Operators of small separate storm sewer systems, industrial facilities that discharge storm water associated with industrial activity or construction activity disturbing 1 to 5 acres.
Industry	Operators of industrial facilities that discharge storm water associated with industrial activity.
Construction Activity	Operators of construction activity disturbing 1 to 5 acres.

This table is not intended to be exhaustive, but rather provides a guide for readers regarding entities likely to be regulated by this action. This table lists the types of entities that EPA is now aware could potentially be regulated by this action. Other types of entities not listed in the table could also be regulated. To determine whether your facility or company is regulated by this action, you should carefully examine the applicability criteria in Secs. 122.26(b), 122.31, 122.32, and 123.35 of the final rule. If you have questions regarding the applicability of this action to a particular entity, consult the person listed in the preceding FOR FURTHER INFORMATION CONTACT section.

Table of Contents:

[[Page 68723]]

I. Background

A. Proposed Rule and Pre-Proposal Outreach

On January 9, 1998 (63 FR 1536), EPA proposed to expand the National Pollutant Discharge Elimination System (NPDES) storm water program to include storm water discharges from municipal separate storm sewer systems (MS4s) and construction sites that were smaller than those previously included in the program. The proposal also addressed industrial sources that have ``no exposure'' of industrial activities and materials to storm water. Today, EPA is promulgating a final rule to implement most of the proposed revisions with minor changes based on public comments received on the proposal. Today's final rule also extends the deadline by which certain industrial facilities operated by municipalities of less than 100,000 population must be covered by a NPDES permit; the deadline is changed from August 7, 2001 until March 10, 2003.

In 1972, Congress amended the Federal Water Pollution Control Act (commonly referred to as the Clean Water Act (CWA)) to prohibit the discharge of any pollutant to waters of the United States from a point source unless the discharge is authorized by an NPDES permit. The NPDES program is a program designed to track point sources and require the implementation of the controls necessary to minimize the discharge of pollutants. Initial efforts to improve water quality under the NPDES program primarily focused on reducing pollutants in industrial process wastewater and municipal sewage. These discharge sources were easily identified as responsible for poor, often drastically degraded, water quality conditions.

As pollution control measures for industrial process wastewater and municipal sewage were implemented and refined, it became increasingly evident that more diffuse sources of water pollution were also significant causes of water quality impairment. Specifically, storm water runoff draining large surface areas, such as agricultural and urban land, was found to be a major cause of water quality impairment, including the nonattainment of designated beneficial uses.

In 1987, Congress amended the CWA to require implementation, in two phases, of a comprehensive national program for addressing storm water discharges. The first phase of the program, commonly referred to as ``Phase I,'' was promulgated on November 16, 1990 (55 FR 47990). Phase I requires NPDES permits for storm water discharge from a large number of priority sources including municipal separate storm sewer systems (``MS4s'') generally serving populations of 100,000 or more and several categories of industrial activity, including construction sites that disturb five or more acres of land.

Today's rule, which is the second phase of the storm water program, expands the existing program to include discharges of storm water from smaller municipalities in urbanized areas and from construction sites that disturb between one and five acres of land. Today's rule allows certain sources to be excluded from the national program based on a demonstrable lack of impact on water quality. The rule also allows other sources not automatically regulated on a national basis to be designated for inclusion based on increased likelihood for localized adverse impact on water quality.

[[Page 68724]]

Today's rule also conditionally excludes storm water discharges from industrial facilities that have ``no exposure'' of industrial activities or materials to storm water. Today's rule and the effort that led to its development are commonly referred to as ``Phase II.'' On August 7, 1995, EPA promulgated a final rule that required facilities to be regulated under Phase II to apply for a NPDES permit by August 7, 2001, unless the NPDES permitting authority designates them as requiring a permit by an earlier date. (60 FR 40230). That rule is referred to as ``the Interim Phase II Rule.'' Today's rule replaces the Interim Phase II rule.

EPA performed extensive outreach and worked with a variety of stakeholders prior to proposing today's rule. On September 9, 1992, EPA published a notice requesting information and public comment on how to prepare regulations under CWA section 402(p)(6) (see 57 FR 41344). The notice identified three sets of issues associated with developing new NPDES storm water regulations: (1) How should EPA identify unregulated sources of storm water to protect water quality, (2) what types of control strategies should EPA develop for these sources, and (3) what are appropriate deadlines for implementing new requirements. The notice recognized that potential sources for coverage under the section 402(p)(6) regulations would fall into two main categories: municipal separate storm sewer systems and individual (commercial and residential) sources. EPA received more than 130 comments on the September 9, 1992, notice. For further discussion of the comments received, see Storm Water Discharges Potentially Addressed by Phase II of the National Pollutant Discharge Elimination System: Report to Congress (EPA, 1995a), pp. 1-21 to 1-22, and Appendix J (which provides a detailed summary of the comments received as they relate to the specific issues raised in the notice).

In early 1993, the Rensselaerville Institute and EPA held public and expert meetings to assist in developing and analyzing options for identifying unregulated sources and possible controls. The report on the 1993 meetings identified two options that were favored by the various groups that participated. One option was a program that allowed States to select sources to be controlled in a manner consistent with criteria developed by EPA. A second option was a tiered approach under which EPA would select high priority sources for control by NPDES permits and States would select other sources for control under a State water quality program other than the NPDES program. For additional details see the ``Report on the EPA Storm Water Management Program (Rensselaerville Study),'' Appendix I of Storm Water Discharges Potentially Addressed by Phase II of the National Pollutant Discharge Elimination System: Report to Congress (EPA, 1995a).

EPA also conducted outreach with representatives of small entities in conjunction with the convening of a Small Business Advocacy Review Panel under the Small Business Regulatory Enforcement Fairness Act (SBREFA). This process is discussed in section IV.E of today's preamble. For additional background see the discussion in the preamble to the proposal for today's rule.

To assist EPA by providing advice and recommendations regarding the urban municipal wet weather water pollution control program, EPA established the Urban Wet Weather Flows Federal Advisory Committee (hereinafter, ``FACA Committee'') under the Federal Advisory Committee Act (FACA). The Office of Management and Budget approved the charter for the FACA Committee on March 10, 1995. The FACA Committee provided a forum for identifying and addressing issues associated with water quality impacts from storm water sources.

The FACA Committee established two subcommittees: the Storm Water Phase II FACA Subcommittee and the Sanitary Sewer Overflows (SSOs) FACA Subcommittee. Consistent with the requirements of FACA, the membership of both the FACA Committee and the subcommittees was balanced among EPA's various outside stakeholder interests, including representatives from municipalities, States, Indian Tribes, EPA, industrial and commercial sectors, agriculture, and environmental and public interest groups.

The Storm Water Phase II FACA Subcommittee (``Subcommittee'') met fourteen times between September 1995 and June 1998. The 32 Subcommittee members discussed possible regulatory frameworks at these meetings as well as during numerous other meetings and conference calls. Members of the FACA Committee provided views regarding the development of the ``no exposure'' provision and other provisions in drafts of the Phase II rule. EPA provided Subcommittee members with four successive drafts of the proposed rule and preamble, outlines of the rule, summaries of the written comments received on each draft, and documents identifying the changes made to each draft. In the course of providing input to the Committee, individual Subcommittee members provided significant input and advice that EPA considered in the context of public comments received. Ultimately, the Subcommittee did not provide a written report back to the FACA Committee, and the FACA Committee did not provide written advice and recommendations to EPA. The Agency, therefore, did not rely on group recommendations in developing today's rule, but does consider the process to have resulted in important public outreach.

B. Water Quality Concerns/Environmental Impact Studies and Assessments

Storm water runoff from lands modified by human activities can harm surface water resources and, in turn, cause or contribute to an exceedance of water quality standards by changing natural hydrologic patterns, accelerating stream flows, destroying aquatic habitat, and elevating pollutant concentrations and loadings. Such runoff may contain or mobilize high levels of contaminants, such as sediment, suspended solids, nutrients (phosphorous and nitrogen), heavy metals and other toxic pollutants, pathogens, toxins, oxygen-demanding substances (organic material), and floatables (U.S. EPA. 1992. Environmental Impacts of Storm Water Discharges: A National Profile. EPA 841-R-92-001. Office of Water. Washington, DC). After a rain, storm water runoff carries these pollutants into nearby streams, rivers, lakes, estuaries, wetlands, and oceans. The highest concentrations of these contaminants often are contained in ``first flush'' discharges, which occur during the first major storm after an extended dry period (Schueler, T.R. 1994. ``First Flush of Stormwater Pollutants Investigated in Texas.'' Note 28. Watershed Protection Techniques 1(2)). Individually and combined, these pollutants impair water quality, threatening designated beneficial uses and causing habitat alteration or destruction.

Uncontrolled storm water discharges from areas of urban development and construction activity negatively impact receiving waters by changing the physical, biological, and chemical composition of the water, resulting in an unhealthy environment for aquatic organisms, wildlife, and humans. The following sections discuss the studies and data that address and support this finding.

Although water quality problems also can occur from agricultural storm water discharges and return flows from irrigated agriculture, this area of

[[Page 68725]]

concern is statutorily exempted from regulation as a point source under the Clean Water Act and is not discussed here. (See CWA section 502(14)). Other storm water sources not specifically identified in the regulations may be of concern in certain areas and can be addressed on a case-by-case (or category-by-category) basis through the NPDES designation authority preserved by CWA section 402(p)(2)(6), as well as today's rule.

1 Urban Development

Urbanization alters the natural infiltration capability of the land and generates a host of pollutants that are associated with the activities of dense populations, thus causing an increase in storm water runoff volumes and pollutant loadings in storm water discharged to receiving waterbodies (U.S. EPA, 1992). Urban development increases the amount of impervious surface in a watershed as farmland, forests, and meadowlands with natural infiltration characteristics are converted into buildings with rooftops, driveways, sidewalks, roads, and parking lots with virtually no ability to absorb storm water. Storm water and snow-melt runoff wash over these impervious areas, picking up pollutants along the way while gaining speed and volume because of their inability to disperse and filter into the ground. What results are storm water flows that are higher in volume, pollutants, and temperature than the flows in less impervious areas, which have more natural vegetation and soil to filter the runoff (U.S. EPA, 1997. Urbanization and Streams: Studies of Hydrologic Impacts. EPA 841-R-97-009. Office of Water. Washington, DC).

Studies reveal that the level of imperviousness in an area strongly correlates with the quality of the nearby receiving waters. For example, a study in the Puget Sound lowland ecoregion found that when the level of basin development exceeded 5 percent of the total impervious area, the biological integrity and physical habitat conditions that are necessary to support natural biological diversity and complexity declined precipitously (May, C.W., E.B. Welch, R.R. Horner, J.R. Karr, and B.W. May. 1997. Quality Indices for Urbanization Effects in Puget Sound Lowland Streams, Technical Report No. 154. University of Washington Water Resources Series). Research conducted in numerous geographical areas, concentrating on various variables and employing widely different methods, has revealed a similar conclusion: stream degradation occurs at relatively low levels of imperviousness, such as 10 to 20 percent (even as low as 5 to 10 percent according to the findings of the Washington study referenced above) (Schueler, T.R. 1994. ``The Importance of Imperviousness.'' Watershed Protection Techniques 1(3); May, C., R.R. Horner, J.R. Karr, B.W. Mar, and E.B. Welch. 1997. ``Effects Of Urbanization On Small Streams In The Puget Sound Lowland Ecoregion.'' Watershed Protection Techniques 2(4); Yoder, C.O., R.J. Miltner, and D. White. 1999. ``Assessing the Status of Aquatic Life Designated Uses in Urban and Suburban Watersheds.'' In Proceedings: National Conference on Retrofits Opportunities in Urban Environments. EPA 625-R-99-002, Washington, DC; Yoder, C.O and R.J. Miltner. 1999. ``Assessing Biological Quality and Limitations to Biological Potential in Urban and Suburban Watersheds in Ohio.'' In Comprehensive Stormwater & Aquatic Ecosystem Management Conference Papers, Auckland, New Zealand). Furthermore, research has indicated that few, if any, urban streams can support diverse benthic communities at imperviousness levels of 25 percent or more. An area of medium density single family homes can be anywhere from 25 percent to nearly 60 percent impervious, depending on the design of the streets and parking (Schueler, 1994).

In addition to impervious areas, urban development creates new pollution sources as population density increases and brings with it proportionately higher levels of car emissions, car maintenance wastes, pet waste, litter, pesticides, and household hazardous wastes, which may be washed into receiving waters by storm water or dumped directly into storm drains designed to discharge to receiving waters. More people in less space results in a greater concentration of pollutants that can be mobilized by, or disposed into, storm water discharges from municipal separate storm sewer systems. A modeling system developed for the Chesapeake Bay indicated that contamination of the Bay and its tributaries from runoff is comparable to, if not greater than, contamination from industrial and sewage sources (Cohn-Lee, R. and D. Cameron. 1992. ``Urban Stormwater Runoff Contamination of the Chesapeake Bay: Sources and Mitigation.'' The Environmental Professional, Vol. 14).

a. Large-Scale Studies and Assessments

In support of today's regulatory designation of MS4s in urbanized areas, the Agency relied on broad-based assessments of urban storm water runoff and related water quality impacts, as well as more site-specific studies. The first national assessment of urban runoff characteristics was completed for the Nationwide Urban Runoff Program (NURP) study (U.S. EPA. 1983. Results of the Nationwide Urban Runoff Program, Volume 1--Final Report. Office of Water. Washington, D.C.). The NURP study is the largest nationwide evaluation of storm water discharges, which includes adverse impacts and sources, undertaken to date.

EPA conducted the NURP study to facilitate understanding of the nature of urban runoff from residential, commercial, and industrial areas. One objective of the study was to characterize the water quality of discharges from separate storm sewer systems that drain residential, commercial, and light industrial (industrial parks) sites. Storm water samples from 81 residential and commercial properties in 22 urban/ suburban areas nationwide were collected and analyzed during the 5-year period between 1978 and 1983. The majority of samples collected in the study were analyzed for eight conventional pollutants and three heavy metals.

Data collected under the NURP study indicated that discharges from separate storm sewer systems draining runoff from residential, commercial, and light industrial areas carried more than 10 times the annual loadings of total suspended solids (TSS) than discharges from municipal sewage treatment plants that provide secondary treatment. The NURP study also indicated that runoff from residential and commercial areas carried somewhat higher annual loadings of chemical oxygen demand (COD), total lead, and total copper than effluent from secondary treatment plants. Study findings showed that fecal coliform counts in urban runoff typically range from tens to hundreds of thousands per hundred milliliters of runoff during warm weather conditions, with the median for all sites being around 21,000/100 ml. This is generally consistent with studies that found that fecal coliform mean values range from 1,600 coliform fecal units (CFU)/100 ml to 250,000 cfu/100 ml (Makepeace, D.K., D.W. Smith, and S.J. Stanley. 1995. ``Urban Storm Water Quality: Summary of Contaminant Data.'' Critical Reviews in Environmental Science and Technology 25(2):93-139). Makepeace, et al., summarized ranges of contaminants from storm water, including physical contaminants such as total solids (76--36,200 mg/L) and copper (up to 1.41 mg/L); organic chemicals; organic compounds, such as oil and grease (up to 110 mg/L); and microorganisms.

[[Page 68726]]

Monitoring data summarized in the NURP study provided important information about urban runoff from residential, commercial, and light industrial areas. The study concluded that the quality of urban runoff can be affected adversely by several sources of pollution that were not directly evaluated in the study, including illicit discharges, construction site runoff, and illegal dumping. Data from the NURP study were analyzed further in the U.S. Geological Survey (USGS) Urban Storm Water Data Base for 22 Metropolitan Areas Throughout the United States study (Driver, N.E., M.H. Mustard, R.B. Rhinesmith, and R.F. Middleburg. 1985. U.S. Geological Survey Urban Storm Water Data Base for 22 Metropolitan Areas Throughout the United States. Report No. 85-337 USGS. Lakewood, CO). The USGS report summarized additional monitoring data compiled during the mid-1980s, covering 717 storm events at 99 sites in 22 metropolitan areas and documented problems associated with metals and sediment concentrations in urban storm water runoff. More recent reports have confirmed the pollutant concentration data collected in the NURP study (Marsalek, J. 1990. ``Evaluation of Pollutant Loads from Urban Nonpoint Sources.'' Wat. Sci. Tech. 22(10/11):23-30; Makepeace, et al., 1995).

Commenters argued that the NURP study does not support EPA's contention that urban activities significantly jeopardize attainment of water quality standards. One commenter argued that the NURP study and the 1985 USGS study are seriously out of date. Because they were issued 10 years or more before the implementation of the current storm water permit program, the data in those reports do not reflect conditions that exist after implementation of permits issued by authorized States and EPA for storm water from construction sites, large municipalities, and industrial activities.

In response, EPA notes that it is not relying solely on the NURP study to describe current water quality impairment. Rather, EPA is citing NURP as a source of data on typical pollutant concentrations in urban runoff. Recent studies have not found significantly different pollutant concentrations in urban runoff when compared to the original NURP data (see Makepeace, et al., 1995; Marsalek, 1990; and Pitt, et al., 1995).

America's Clean Water--the States' Nonpoint Source Assessment (Association of State and Interstate Water Pollution Control Administrators (ASIWPCA). 1985. America's Clean Water--The States' Nonpoint Source Assessment. Prepared in cooperation with the U.S. EPA, Office of Water, Washington, DC), a comprehensive study of diffuse pollution sources conducted under the sponsorship of the Association of State and Interstate Water Pollution Control Administrators (ASIWPCA) and EPA revealed that 38 States reported urban runoff as a major cause of designated beneficial use impairment and 21 States reported storm water runoff from construction sites as a major cause of beneficial use impairment. In addition, the 1996 305(b) Report (U.S. EPA. 1998. The National Water Quality Inventory, 1996 Report to Congress. EPA 841-R-97-008. Office of Water. Washington, DC), provides a national assessment of water quality based on biennial reports submitted by the States as required under CWA section 305(b) of the CWA. In the CWA 305(b) reports, States, Tribes, and Territories assess their individual water quality control programs by examining the attainment or nonattainment of the designated uses assigned to their rivers, lakes, estuaries, wetlands, and ocean shores. A designated use is the legally applicable use specified in a water quality standard for a watershed, waterbody, or segment of a waterbody. The designated use is the desirable use that the water quality should support. Examples of designated uses include drinking water supply, primary contact recreation (swimming), and aquatic life support. Each CWA 305(b) report indicates the assessed fraction of a State's waters that are fully supporting, partially supporting, or not supporting designated beneficial uses.

In their reports, States, Tribes, and Territories first identified and then assigned the sources of water quality impairment for each impaired waterbody using the following categories: industrial, municipal sewage, combined sewer overflows, urban runoff/storm sewers, agricultural, silvicultural, construction, resource extraction, land disposal, hydrologic modification, and habitat modification. The 1996 Inventory, based on a compilation of 60 individual 305(b) reports submitted by States, Tribes, and Territories, assessed the following percentages of total waters nationwide: 19 percent of river and stream miles; 40 percent of lake, pond, and reservoir acres; 72 percent of estuary square miles; and 6 percent of ocean shoreline waters. The 1996 Inventory indicated that approximately 40 percent of the Nation's assessed rivers, lakes, and estuaries are impaired. Waterbodies deemed as ``impaired'' are either partially supporting designated uses or not supporting designated uses.

The 1996 Inventory also found urban runoff/discharges from storm sewers to be a major source of water quality impairment nationwide. Urban runoff/storm sewers were found to be a source of pollution in 13 percent of impaired rivers; 21 percent of impaired lakes, ponds, and reservoirs; and 45 percent of impaired estuaries (second only to industrial discharges). In addition, urban runoff was found to be the leading cause of ocean impairment for those ocean miles surveyed.

In addition, a recent USGS study of urban watersheds across the United States has revealed a link between urban development and contamination of local waterbodies. The study found the highest levels of organic contaminants, known as polycyclic aromatic hydrocarbons (PAHs) (products of combustion of wood, grass, and fossil fuels), in the reservoirs of urbanized watersheds (U.S. Geological Survey (USGS). 1998. Research Reveals Link Between Development and Contamination in Urban Watersheds. USGS news release. USGS National Water-Quality Assessment Program).

Urban storm water also can contribute significant amounts of toxicants to receiving waters. Pitt, et. al. (1993), found heavy metal concentrations in the majority of samples analyzed. Industrial or commercial areas were likely to be the most significant pollutant source areas (Pitt, R., R. Field, M. Lalor, M. Brown 1993. ``Urban stormwater toxic pollutants: assessment, sources, and treatability'' Water Environment Research, 67(3):260-75).

b. Local and Watershed-Based Studies

In addition to the large-scale nationwide studies and assessments, a number of local and watershed-based studies from across the country have documented the detrimental effects of urban storm water runoff on water quality. A study of urban streams in Milwaukee County, Wisconsin, found local streams to be highly degraded due primarily to urban runoff, while three studies in the Atlanta, Georgia, region were characterized as being ``the first documentation in the Southeast of the strong negative relationship between urbanization and stream quality that has been observed in other ecoregions'' (Masterson, J. and R. Bannerman. 1994. ``Impacts of Storm Water Runoff on Urban Streams in Milwaukee County, Wisconsin.'' Paper presented at National Symposium on Water Quality: American Water Resources Association; Schueler, T.R. 1997. ``Fish Dynamics in Urban Streams Near Atlanta, Georgia.''

[[Page 68727]]

Technical Note 94. Watershed Protection Techniques 2(4)). Several other studies, including those performed in Arizona (Maricopa County), California (San Jose's Coyote Creek), Massachusetts (Green River), Virginia (Tuckahoe Creek), and Washington (Puget Sound lowland ecoregion), all had the same finding: runoff from urban areas greatly impair stream ecology and the health of aquatic life; the more heavily developed the area, the more detrimental the effects (Lopes, T. and K. Fossum. 1995. ``Selected Chemical Characteristics and Acute Toxicity of Urban Stormwater, Streamflow, and Bed Material, Maricopa County, Arizona.'' Water Resources Investigations Report 95-4074. USGS; Pitt, R. 1995. ``Effects of Urban Runoff on Aquatic Biota.'' In Handbook of Ecotoxicology; Pratt, J. and R. Coler. 1979. ``Ecological Effects of Urban Stormwater Runoff on Benthic Macroinvertebrates Inhabiting the Green River, Massachusetts.'' Completion Report Project No. A-09 Water Resources Research Center. University of Massachusetts at Amherst.; Schueler, T.R. 1997. ``Historical Change in a Warmwater Fish Community in an Urbanizing Watershed.'' Technical Note 93. Watershed Protection Techniques 2(4); May, C., R. Horner, J. Karr, B. Mar, and E. Welch. 1997. ``Effects Of Urbanization On Small Streams In The Puget Sound Lowland Ecoregion.'' Watershed Protection Techniques 2(4)).

Pitt and others also described the receiving water effects on aquatic organisms associated with urban runoff (Pitt, R.E. 1995. ``Biological Effects of Urban Runoff Discharges'' In Stormwater Runoff and Receiving Systems: Impact, Monitoring, and Assessment, ed. E.E Herricks, Lewis Publishers; Crunkilton, R., J. Kleist, D. Bierman, J. Ramcheck, and W. DeVita. 1999. ``Importance of Toxicity as a Factor Controlling the Distribution of Aquatic Organisms in an Urban Stream.'' In Comprehensive Stormwater & Aquatic Ecosystem Management Conference Papers. Auckland, New Zealand).

In Wisconsin, runoff samples were collected from streets, parking lots, roofs, driveways, and lawns. Source areas were broken up into residential, commercial, and industrial. Geometric mean concentration data for residential areas included total solids of about 500-800 mg/L from streets and 600 mg/L from lawns. Fecal coliform data from residential areas ranged from 34,000 to 92,000 cfu/100 mL for streets and driveways. Contaminant concentration data from commercial and industrial source areas were lower for total solids and fecal coliform, but higher for total zinc (Bannerman, R.T., D.W. Owens, R.B. Dods, and N.J. Hornewer. 1993. ``Sources of Pollutants in Wisconsin Stormwater.'' Wat. Sci. Tech. 28(3-5):241-59).

Bannerman, et al. also found that streets contribute higher loads of pollutants to urban storm water than any other residential development source. Two small urban residential watersheds were evaluated to determine that lawns and streets are the largest sources of total and dissolved phosphorus in the basins (Waschbusch, R.J., W.R. Selbig, and R.T. Bannerman. 1999. ``Sources of Phosphorus in Stormwater and Street Dirt from Two Urban Residential Basins In Madison, Wisconsin, 1994-95.'' Water Resources Investigations Report 99-4021. U.S. Geological Survey). A number of other studies have indicated that urban roadways often contain significant quantities of metal elements and solids (Sansalone, J.J. and S.G. Buchberger. 1997. ``Partitioning and First Flush of Metals in Urban Roadway Storm Water.'' ASCE Journal of Environmental Engineering 123(2); Sansalone, J.J., J.M. Koran, J.A. Smithson, and S.G. Buchberger. 1998. ``Physical Characteristics of Urban Roadway Solids Transported During Rain Events'' ASCE Journal of Environmental Engineering 124(5); Klein, L.A., M. Lang, N. Nash, and S.L. Kirschner. 1974. ``Sources of Metals in New York City Wastewater'' J. Water Pollution Control Federation 46(12):2653-62; Barrett, M.E, R.D. Zuber, E.R. Collins, J.F. Malina, R.J. Charbeneau, and G.H Ward., 1993. ``A Review and Evaluation of Literature Pertaining to the Quantity and Control of Pollution from Highway Runoff and Construction.'' Research Report 1943-1. Center for Transportation Research, University of Texas, Austin).

c. Beach Closings/Advisories

Urban wet weather flows have been recognized as the primary sources of estuarine pollution in coastal communities. Urban storm water runoff, sanitary sewer overflows, and combined sewer overflows have become the largest causes of beach closings in the United States in the past three years. Storm water discharges from urban areas not only pose a threat to the ecological environment, they also can substantially affect human health. A survey of coastal and Great Lakes communities reports that in 1998, more than 1,500 beach closings and advisories were associated with storm water runoff (Natural Resources Defense Council. 1999. ``A Guide to Water Quality at Vacation Beaches.'' New York, NY). Other reports also document public health, shellfish bed, and habitat impacts from storm water runoff, including more than 823 beach closings/advisories issued in 1995 and more than 407 beach closing/advisories issued in 1996 due to urban runoff (Natural Resources Defense Council. 1996. Testing the Waters Volume VI: Who Knows What You're Getting Into. New York, NY; NRDC. 1997. Testing the Waters Volume VII: How Does Your Vacation Beach Rate. New York, NY; Morton, T. 1997. Draining to the Ocean: The Effects of Stormwater Pollution on Coastal Waters. American Oceans Campaign, Santa Monica, CA). The Epidemiological Study of Possible Adverse Health Effects of Swimming in Santa Monica Bay (Haile, R.W., et. al. 1996. ``An Epidemiological Study of Possible Adverse Health Effects of Swimming in Santa Monica Bay.'' Final Report prepared for the Santa Monica Bay Restoration Project) concluded that there is a 57 percent higher rate of illness in swimmers who swim adjacent to storm drains than in swimmers who swim more than 400 yards away from storm drains. This and other studies document a relationship between gastrointestinal illness in swimmers and water quality, the latter of which can be heavily compromised by polluted storm water discharges.

2. Non-Storm Water Discharges Through Municipal Storm Sewers

Studies have shown that discharges from MS4s often include wastes and wastewater from non-storm water sources. Federal regulations (Sec. 122.26(b)(2)) define an illicit discharge as ``* * * any discharge to an MS4 that is not composed entirely of storm water * * *,'' with some exceptions. These discharges are ``illicit'' because municipal storm sewer systems are not designed to accept, process, or discharge such wastes. Sources of illicit discharges include, but are not limited to: sanitary wastewater; effluent from septic tanks; car wash, laundry, and other industrial wastewaters; improper disposal of auto and household toxics, such as used motor oil and pesticides; and spills from roadway and other accidents.

Illicit discharges enter the system through either direct connections (e.g., wastewater piping either mistakenly or deliberately connected to the storm drains) or indirect connections (e.g., infiltration into the MS4 from cracked sanitary systems, spills collected by drain outlets, and paint or used oil dumped directly into a drain). The result is untreated discharges that contribute high levels of pollutants,

[[Page 68728]]

including heavy metals, toxics, oil and grease, solvents, nutrients, viruses and bacteria into receiving waterbodies. The NURP study, discussed earlier, found that pollutant levels from illicit discharges were high enough to significantly degrade receiving water quality and threaten aquatic, wildlife, and human health. The study noted particular problems with illicit discharges of sanitary wastes, which can be directly linked to high bacterial counts in receiving waters and can be dangerous to public health.

Because illicit discharges to MS4s can create severe widespread contamination and water quality problems, several municipalities and urban counties performed studies to identify and eliminate such discharges. In Michigan, the Ann Arbor and Ypsilanti water quality projects inspected 660 businesses, homes, and other buildings and identified 14 percent of the buildings as having improper storm sewer drain connections. The program assessment revealed that, on average, 60 percent of automobile-related businesses, including service stations, automobile dealerships, car washes, body shops, and light industrial facilities, had illicit connections to storm sewer drains. The program assessment also showed that a majority of the illicit discharges to the storm sewer system resulted from improper plumbing and connections, which had been approved by the municipality when installed (Washtenaw County Statutory Drainage Board. 1987. Huron River Pollution Abatement Program).

In addition, an inspection of urban storm water outfalls draining into Inner Grays, Washington, indicated that 32 percent of these outfalls had dry weather flows. Of these flows, 21 percent were determined to have pollutant levels higher than the pollutant levels expected in typical urban storm water runoff characterized in the NURP study (U.S. EPA. 1993. Investigation of Inappropriate Pollutant Entries Into Storm Drainage Systems--A User's Guide. EPA 600/R-92/238. Office of Research and Development. Washington, DC). That same document reports a study in Toronto, Canada, that found that 59 percent of outfalls from the MS4 had dry-weather flows. Chemical tests revealed that 14 percent of these dry-weather flows were determined to be grossly polluted.

Inflows from aging sanitary sewer collection systems are one of the most serious illicit discharge-related problems. Sanitary sewer systems frequently develop leaks and cracks, resulting in discharges of pollutants to receiving waters through separate storm sewers. These pollutants include sanitary waste and materials from sewer main construction (e.g., asbestos cement, brick, cast iron, vitrified clay). Municipalities have long recognized the reverse problem of storm water infiltration into sanitary sewer collection systems; this type of infiltration often disrupts the operation of the municipal sewage treatment plant.

The improper disposal of materials is another illicit discharge-related problem that can result in contaminated discharges from separate storm sewer systems in two ways. First, materials may be disposed of directly in a catch basin or other storm water conveyance. Second, materials disposed of on the ground may either drain directly to a storm sewer or be washed into a storm sewer during a storm event. Improper disposal of materials to street catch basins and other storm sewer inlets often occurs when people mistakenly believe that disposal to such areas is an environmentally sound practice. Part of the confusion may occur because some areas are served by combined sewer systems, which are part of the sanitary sewer collection system, and people assume that materials discharged to a catch basin will reach a municipal sewage treatment plant. Materials that are commonly disposed of improperly include used motor oil; household toxic materials; radiator fluids; and litter, such as disposable cups, cans, and fast-food packages. EPA believes that there has been increasing success in addressing these problems through initiatives such as storm drain stenciling and recycling programs, including household hazardous waste special collection days.

Programs that reduce illicit discharges to separate storm sewers have improved water quality in several municipalities. For example, Michigan's Huron River Pollution Abatement Program found the elimination of illicit connections caused a measurable improvement in the water quality of the Washtenaw County storm sewers and the Huron River (Washtenaw County Statutory Drainage Board, 1987). In addition, an illicit detection and remediation program in Houston, Texas, has significantly improved the water quality of Buffalo Bayou. Houston estimated that illicit flows from 132 sources had a flow rate as high as 500 gal/min. Sources of the illicit discharges included broken and plugged sanitary sewer lines, illicit connections from sanitary lines to storm sewer lines, and floor drain connections (Glanton, T., M.T. Garrett, and B. Goloby. 1992. The Illicit Connection: Is It the Problem? Wat. Env. Tech. 4(9):63-8).

3. Construction Site Runoff

Storm water discharges generated during construction activities can cause an array of physical, chemical, and biological water quality impacts. Specifically, the biological, chemical, and physical integrity of the waters may become severely compromised. Water quality impairment results, in part, because a number of pollutants are preferentially absorbed onto mineral or organic particles found in fine sediment. The interconnected process of erosion (detachment of the soil particles), sediment transport, and delivery is the primary pathway for introducing key pollutants, such as nutrients (particularly phosphorus), metals, and organic compounds into aquatic systems (Novotny, V. and G. Chesters. 1989. ``Delivery of Sediment and Pollutants from Nonpoint Sources: A Water Quality Perspective.'' Journal of Soil and Water Conservation, 44(6):568-76). Estimates indicate that 80 percent of the phosphorus and 73 percent of the Kjeldahl nitrogen in streams is associated with eroded sediment (U.S. Department of Agriculture. 1989. ``The Second RCA Appraisal, Soil, Water and Related Resources on Nonfederal Land in the United States, Analysis of Condition and Trends.'' Cited in Fennessey, L.A.J., and A.R. Jarrett. 1994. ``The Dirt in a Hole: a Review of Sedimentation Basins for Urban Areas and Construction Sites.'' Journal of Soil and Water Conservation, 49(4):317-23).

In watersheds experiencing intensive construction activity, the localized impacts of water quality may be severe because of high pollutant loads, primarily sediments. Siltation is the largest cause of impaired water quality in rivers and the third largest cause of impaired water quality in lakes (U.S. EPA, 1998). The 1996 305(b) report also found that construction site discharges were a source of pollution in: 6 percent of impaired rivers; 11 percent of impaired lakes, ponds, and reservoirs; and 11 percent of impaired estuaries. Introduction of coarse sediment (coarse sand or larger) or a large amount of fine sediment is also a concern because of the potential of filling lakes and reservoirs (along with the associated remediation costs for dredging), as well as clogging stream channels (e.g., Paterson, R.G., M.I. Luger, E.J. Burby, E.J. Kaiser, H.R. Malcolm, and A.C. Beard. 1993. ``Costs and Benefits of Urban Erosion and Sediment Control: North Carolina Experience.'' Environmental Management 17(2):167-78). Large inputs of coarse sediment into

[[Page 68729]]

stream channels initially will reduce stream depth and minimize habitat complexity by filling in pools (U.S. EPA. 1991. Monitoring Guidelines to Evaluate Effects of Forestry Activities on Streams in the Pacific Northwest and Alaska. EPA 910/9-91-001. Seattle, WA). In addition, studies have shown that stream reaches affected by construction activities often extend well downstream of the construction site. For example, between 4.8 and 5.6 kilometers of stream below construction sites in the Patuxent River watershed were observed to be impacted by sediment inputs (Fox, H.L. 1974. ``Effects of Urbanization on the

Patuxent River, with Special Emphasis on Sediment Transport, Storage, and Migration.'' Ph.D. dissertation. Johns Hopkins University, Baltimore, MD. As Cited in Klein, R.D. 1979. ``Urbanization and Stream Quality Impairment.'' Water Resources Bulletin 15(4): 948-63).

A primary concern at most construction sites is the erosion and transport process related to fine sediment because rain splash, rills (i.e., a channel small enough to be removed by normal agricultural practices and typically less than 1-foot deep), and sheetwash encourage the detachment and transport of this material to waterbodies (Storm Water Quality Task Force. 1993. California Storm Water Best Management Practice Handbooks--Construction Activity. Oakland, CA: Blue Print Service). Construction sites also can generate other pollutants associated with onsite wastes, such as sanitary wastes or concrete truck washout.

Although streams and rivers naturally carry sediment loads, erosion from construction sites and runoff from developed areas can elevate these loads to levels well above those in undisturbed watersheds. It is generally acknowledged that erosion rates from construction sites are much greater than from almost any other land use (Novotny, V. and H. Olem. 1994. Water Quality: Prevention, Identification, and Management of Diffuse Pollution. New York: Van Nostrand Reinhold). Results from both field studies and erosion models indicate that erosion rates from construction sites are typically an order of magnitude larger than row crops and several orders of magnitude greater than rates from well-vegetated areas, such as forests or pastures (USDA. 1970. ``Controlling Erosion on Construction Sites.'' Agriculture Information Bulletin, Washington, DC; Meyer, L.D., W.H. Wischmeier, and W.H. Daniel. 1971. ``Erosion, Runoff and Revegetation of Denuded Construction Sites.'' Transactions of the ASAE 14(1):138-41; Owen, O.S. 1975. Natural Resource Conservation. New York: MacMillan. As cited in Paterson, et al., 1993).

A recent review of the efficiency of sediment basins indicated that inflows from 12 construction sites had a mean TSS concentration of about 4,500 mg/L (Brown, W.E. 1997. ``The Limits of Settling.'' Technical Note No. 83. Watershed Protection Techniques 2(3)). In Virginia, suspended sediment concentrations from housing construction sites were measured at 500-3,000 mg/L, or about 40 times larger than the concentrations from already-developed urban areas (Kuo, C.Y. 1976. ``Evaluation of Sediment Yields Due to Urban Development.'' Bulletin No. 98. Virginia Water Resources Research Center, Virginia Polytechnic Institute and State University, Blacksburg, VA)..

Similar impacts from storm water runoff have been reported in a number of other studies. For example, Daniel, et al., monitored three residential construction sites in southeastern Wisconsin and determined that annual sediment yields were more than 19 times the yields from agricultural areas (Daniel, T.C., D. McGuire, D. Stoffel, and B. Miller. 1979. ``Sediment and Nutrient Yield from Residential Construction Sites'' Journal of Environmental Quality 8(3):304-08). Daniel, et al., identified total storm runoff, followed by peak storm runoff, as the most influential factors controlling the sediment loadings from residential construction sites. Daniel, et al., also found that suspended sediment concentrations were 15,000-20,000 mg/L in moderate events and up to 60,000 mg/L in larger events.

Wolman and Schick (Wolman, M.G. and A.P. Schick. 1967. ``Effects of Construction on Fluvial Sediment, Urban and Suburban Areas of Maryland.'' Water Resources Research 3(2): 451-64) studied the impacts of development on fluvial systems in Maryland and determined that sediment yields in areas undergoing construction were 1.5 to 75 times greater than detected in natural or agricultural catchments. The authors summarize the potential impacts of construction on sediment yields by stating that ``the equivalent of many decades of natural or even agricultural erosion may take place during a single year from areas cleared for construction'' (Wolman and Schick, 1967).

A number of studies have examined the effects of road construction on erosion rates and sediment yields. A highway construction project in West Virginia disturbed only 4.2 percent of a 4.72-square-mile basin, but resulted in a three-fold increase in suspended sediment yields (Downs, S.C. and D.H. Appel. 1986. Progress Report on the Effects of Highway Construction on Suspended-Sediment Discharge in the Coal River and Trace Fork, West Virginia, 1975-81. USGS Water Resources Investigations Report 84-4275. Charleston, WV). During the largest storm event, it was estimated that 80 percent of the sediment in the stream originated from the construction site. As is often the case, the increase in suspended sediment load could not be detected further downstream, where the drainage area was more than 50 times larger (269 square miles).

Another study evaluated the effect of 290 acres of highway construction on watersheds ranging in size from 5 to 38 square miles. Suspended sediment loads in the smallest watershed increased by 250 percent, and the estimated sediment yield from the construction area was 37 tons/acre during a 2-year period (Hainly, R.A. 1980. The Effects of Highway Construction on Sediment Discharge into Blockhouse Creek and Stream Valley Run, Pennsylvania. USGS Water Resources Investigations Report 80-68. Harrisburg, PA). A more recent study in Hawaii showed that highway construction increased suspended sediment loads by 56 to 76 percent in three small (1 to 4 square mile) basins (Hill, B.R. 1996. Streamflow and Suspended-Sediment Loads Before and During Highway Construction, North Halawa, Haiku, and Kamooalii Drainage Basins, Oahu, Hawaii, 1983-91. USGS Water Resources Investigations Report 96-4259. Honolulu, HI). A 1970 study determined that sediment yields from construction areas can be as much as 500 times the levels detected in rural areas (National Association of Counties Research Foundation. 1970. Urban Soil Erosion and Sediment Control. Water Pollution Control Research Series, Program #15030 DTL. Federal Water Quality Administration, U.S. Department of Interior. Washington, DC)

Yorke and Herb (Yorke, T.H., and W.J. Herb. 1978. Effects of Urbanization on Streamflow and Sediment Transport in the Rock Creek and Anacostia River Basins, Montgomery County, Maryland, 1962-74. USGS Professional Paper 1003, Washington, DC) evaluated nine subbasins in the Maryland portion of the Anacostia watershed for more than a decade in an effort to define the impacts of changing land use/land cover on sediment in runoff. Average annual suspended sediment yields for construction sites ranged from 7 to 100 tons/acre. Storm water discharges from construction sites that occur when the land area is disturbed (and prior to

[[Page 68730]]

surface stabilization) can significantly impact designated uses. Examples of designated uses include public water supply, recreation, and propagation of fish and wildlife. The siltation process described previously can threaten all three designated uses by (1) depositing high concentrations of pollutants in public water supplies; (2) decreasing the depth of a waterbody, which can reduce the volume of a reservoir or result in limited use of a water body by boaters, swimmers, and other recreational enthusiasts; and (3) directly impairing the habitat of fish and other aquatic species, which can limit their ability to reproduce.

Excess sediment can cause a number of other problems for waterbodies. It is associated with increased turbidity and reduced light penetration in the water column, as well as more long-term effects associated with habitat destruction and increased difficulty in filtering drinking water. Numerous studies have examined the effect that excess sediment has on aquatic ecosystems. For example, sediment from road construction activity in Northern Virginia reduced aquatic insect and fish communities by up to 85 percent and 40 percent, respectively (Reed, J.R. 1997. ``Stream Community Responses to Road Construction Sediments.'' Bulletin No. 97. Virginia Water Resources Research Center, Virginia Polytechnic Institute, Blacksburg, VA. As cited in Klein, R.D. 1990. A Survey of Quality of Erosion and Sediment Control and Storm Water Management in the Chesapeake Bay Watershed. Annapolis, MD: Chesapeake Bay Foundation). Other studies have shown that fine sediment (fine sand or smaller) adversely affects aquatic ecosystems by reducing light penetration, impeding sight-feeding, smothering benthic organisms, abrading gills and other sensitive structures, reducing habitat by clogging interstitial spaces within a streambed, and reducing the intergravel dissolved oxygen by reducing the permeability of the bed material (Everest, F.H., J.C. Beschta, K.V. Scrivener, J.R. Koski, J.R. Sedell, and C.J. Cederholm. 1987. ``Fine Sediment and Salmonid Production: A Paradox.'' Streamside Management: Forestry and Fishery Interactions, Contract No. 57, Institute of Forest Resources, University of Washington, Seattle, WA). For example, 4.8 and 5.6 kilometers of stream below construction sites in the Patuxent River watershed in Maryland were found to have fine sediment amounts 15 times greater than normal (Fox, 1974. As cited in Klein, 1979). Benthic organisms in the streambed can be smothered by sediment deposits, causing changes in aquatic flora and fauna, such as fish species composition (Wolman and Schick, 1967). In addition, the primary cause of coral reef degradation in coastal areas is attributed to land disturbances and dredging activities due to urban development (Rogers, C.S. 1990. ``Responses of Coral Reefs and Reef Organizations to Sedimentation.'' Marine Ecology Progress Series, 62:185-202).

EPA believes that the water quality impact from small construction sites is as high as or higher than the impact from larger sites on a per acre basis. The concentration of pollutants in the runoff from smaller sites is similar to the concentrations in the runoff from larger sites. The proportion of sediment that makes it from the construction site to surface waters is likely the same for larger and smaller construction sites in urban areas because the runoff from either site is usually delivered directly to the storm drain network where there is no opportunity for the sediment to be filtered out.

The expected contribution of total sediment yields from small sites depends, in part, on the extent to which erosion and sedimentation controls are being applied. Because current storm water regulations are more likely to require erosion and sedimentation controls on larger sites in urban areas, smaller construction sites that lack such programs are likely to contribute a disproportionate amount of the total sediment from construction activities (MacDonald, L.H. 1997. Technical Justification for Regulating Construction Sites 1-5 Acres in Size. Unpublished report submitted to U.S. EPA, Washington, DC). Smaller construction sites are less likely to have an effective plan to control erosion and sedimentation, are less likely to properly implement and maintain their plans, and are less likely to be inspected (Brown, W. and D. Caraco. 1997. Controlling Storm Water Runoff Discharges from Small Construction Sites: A National Review. Submitted to Office of Wastewater Management, U.S. EPA, Washington, DC., by the Center for Watershed Protection, Silver Spring, MD). The proportion of sediment that makes it from the construction site to surface waters is likely the same for larger and smaller construction sites in urban areas because the runoff from either site is usually delivered directly to the storm drain network, where there is no opportunity for the sediment to be filtered out.

To confirm its belief that sediment yields from small sites are as high as or higher than the 20 to 150 tons/acre/year measured from larger sites, EPA gave a grant to the Dane County, Wisconsin Land Conservation Department, in cooperation with the USGS, to evaluate sediment runoff from two small construction sites. The first was a 0.34 acre residential lot and the second was a 1.72 acre commercial office development. Runoff from the sites was channeled to a single discharge point for monitoring. Each site was monitored before, during, and after construction.

The Dane County study found that total solids concentrations from these small sites are similar to total solids concentrations from larger construction sites. Results show that for both of the study sites, total solids and suspended solids concentrations were significantly higher during construction than either before or after construction. For example, preconstruction total solids concentrations averaged 642 mg/L during the period when ryegrass was established, active construction total solids concentrations averaged 2,788 mg/L, and post-construction total solids concentrations averaged 132 mg/L (on a pollutant load basis, this equaled 7.4 lbs preconstruction, 35 lbs during construction, and 0.6 lbs post-construction for total solids). While this site was not properly stabilized before construction, after construction was complete and the site was stabilized, post-construction concentrations were more than 20 times less than during construction. The results were even more dramatic for the commercial site. The commercial site had one preconstruction event, which resulted in total solids concentrations of 138 mg/L, while active construction averaged more than 15,000 mg/L and post-construction averaged only 200 mg/L (on a pollutant load basis, this equaled 0.3 lbs preconstruction, 490 lbs during construction, and 13.4 lbs post-construction for total solids). The active construction period resulted in more than 75 times more sediment than either before or after construction (Owens, D.W., P. Jopke, D.W. Hall, J. Balousek and A. Roa. 1999. ``Soil Erosion from Small Construction Sites.'' Draft USGS Fact Sheet. USGS and Dane County Land Conservation Department, WI). The total solids concentrations from these small sites in Wisconsin are similar to total solids concentrations from larger construction sites. For example, a study evaluating the effects of highway construction in West Virginia found that a small storm produced a sediment concentration of 7,520 mg/L (Downs and Appel, 1986).

One important aspect of small construction sites is the number of small sites relative to larger construction sites

[[Page 68731]]

and total land area within the watershed. Brown and Caraco surveyed 219 local jurisdictions to assess erosion and sediment control (ESC) programs. Seventy respondents provided data on the number of ESC permits for construction sites smaller than 5 acres. In 27 cases (38 percent of the respondents), more than three-quarters of the permits were for sites smaller than 5 acres; in another 18 cases (26 percent), more than half of the permits were for sites smaller than 5 acres.

In addition, data on the total acreage disturbed by smaller construction sites have been collected recently in two States (MacDonald, 1997). The most recent and complete data set is the listing of the disturbed area for each of the 3,831 construction sites permitted in North Carolina for 1994-1995 and 1995-1996. Nearly 61 percent of the sites that were 1 acre or larger were between 1.0 and 4.9 acres in size. This proportion was consistent between years. Data showed that this range of sites accounted for 18 percent of the total area disturbed by construction. The values showed very little variation between the 2 years of data. The total disturbed area for all sites over this 2-year period was nearly 33,000 acres, or about 0.1 percent of the total area of North Carolina.

EPA estimates that construction sites disturbing greater than 5 acres disturb 2.1-million acres of land (78.1 percent of the total) while sites disturbing between 1 and 5 acres of land disturb 0.5-million acres of land (19.4 percent). The remaining sites on less than 1 acres of land disturb 0.07-million acres of land (only 2.5 percent of the total). Given the high erosion rates associated with all construction sites, small construction sites can be a significant source of water quality impairment, particularly in small watersheds that are undergoing rapid development. Exempting sites under 1 acre will exclude only about 2.5 percent of acreage from program coverage, but will exclude a far higher number of sites, approximately 25 percent.

Several studies have determined that the most effective construction runoff control programs rely on local plan review and field enforcement (Paterson, R. G. 1994. ``Construction Practices: the Good, the Bad, and the Ugly.'' Watershed Protection Techniques 1(3)). In his review, Paterson suggests that, given the critical importance of field implementation of erosion and sediment control programs and the apparent shortcomings that exist, much more focus should be given to plan implementation.

Several commenters disputed the data presented in the proposed rule for storm water discharges from smaller construction sites. One commenter stated that EPA has not adequately explained the basis for permitting construction activity down to 1 disturbed acre. Another commenter stated that EPA did not present sufficient data on water quality impacts from construction sites disturbing less than 5 acres.

EPA believes that the data presented above sufficiently support nationwide designation of storm water discharges from construction activity disturbing more than 1 acre. Based on total disturbed land area within a watershed, the cumulative effects of numerous small construction sites can have impacts similar to those of larger sites in a particular area. In addition, waivers for storm water discharges from smaller construction activity will exclude sites not expected to impair water quality. EPA will continue to collect water quality data on construction site storm water runoff.

C. Statutory Background

In 1972, Congress enacted the CWA to prohibit the discharge of any pollutant to waters of the United States from a point source unless the discharge is authorized by an NPDES permit. Congress added CWA section 402(p) in 1987 to require implementation of a comprehensive program for addressing storm water discharges. Section 402(p)(1) required EPA or NPDES-authorized States or Tribes to issue NPDES permits for the following five classes of storm water discharges composed entirely of storm water (``storm water discharges'') specifically listed under section 402(p)(2):

(A) a discharge subject to an NPDES permit before February 4, 1987

(B) a discharge associated with industrial activity

(C) a discharge from a municipal separate storm sewer system serving a population of 250,000 or more

(D) a discharge from a municipal separate storm sewer system serving a population of 100,000 or more but less than 250,000

(E) a discharge that an NPDES permitting authority determines to be contributing to a violation of a water quality standard or a significant contributor of pollutants to the waters of the United States.

Section 402(p)(3)(A) requires storm water discharges associated with industrial activity to meet all applicable provisions of section 402 and section 301 of the CWA, including technology-based requirements and any more stringent requirements necessary to meet water quality standards. Section 402(p)(3)(B) establishes NPDES permit standards for discharges from municipal separate storm sewer systems, or MS4s. NPDES permits for discharges from MS4s (1) may be issued on a system or jurisdiction-wide basis, (2) must include a requirement to effectively prohibit non-storm water discharges into the storm sewers, and (3) must require controls to reduce pollutant discharges to the maximum extent practicable, including best management practices, and other provisions as the Administrator or the States determine to be appropriate for the control of such pollutants. At this time, EPA determines that water quality-based controls, implemented through the iterative processes described today are appropriate for the control of such pollutants and will result in reasonable further progress towards attainment of water quality standards. See sections II.L and II.H.3 of the preamble.

In CWA section 402(p)(4), Congress established statutory deadlines for the initial steps in implementing the NPDES program for storm water discharges. This section required development of NPDES permit application regulations, submission of NPDES permit applications, issuance of NPDES permits for sources identified in section 402(p)(2), and compliance with NPDES permit conditions. In addition, this section required industrial facilities and large MS4s to submit NPDES permit applications for storm water discharges by February 4, 1990. Medium MS4s were to submit NPDES permit applications by February 4, 1992. EPA and authorized NPDES States were prohibited from requiring an NPDES permit for any other storm water discharges until October 1, 1994.

Section 402(p)(5) required EPA to conduct certain studies and submit a report to Congress. This requirement is discussed in the following section.

Section 402(p)(6) requires EPA, in consultation with States and local officials, to issue regulations for the designation of additional storm water discharges to be regulated to protect water quality. It also requires EPA to extend the existing storm water program to regulate newly designated sources. At a minimum, the extension must establish (1) priorities, (2) requirements for State storm water management programs, and (3) expeditious deadlines. Section 402(p)(6) specifies that the program may include performance standards, guidelines, guidance, and management practices and treatment requirements, as

[[Page 68732]]

appropriate. Today's rule implements this section.

D. EPA's Reports to Congress

Under CWA section 402(p)(5), EPA, in consultation with the States, was required to conduct a study. The study was to identify unregulated sources of storm water discharges, determine the nature and extent of pollutants in such discharges, and establish procedures and methods to mitigate the impacts of such discharges on water quality. Section 402(p)(5) also required EPA to report the results of the first two components of that study to Congress by October 1, 1988, and the final report by October 1, 1989.

In March 1995, EPA submitted to Congress a report that reviewed and analyzed the nature of storm water discharges from municipal and industrialacilities that were not already regulated under the initial NPDES regulations for storm water (U.S. Environmental Protection Agency, Office of Water. 1995. Storm Water Discharges Potentially Addressed by Phase II of the National Pollutant Discharge Elimination System Storm Water Program: Report to Congress. Washington, D.C. EPA 833-K-94-002) (``Report''). The Report also analyzed associated pollutant loadings and water quality impacts from these unregulated sources. Based on identification of unregulated municipal sources and analysis of information on impacts of storm water discharges from municipal sources, the Report recommended that the NPDES program for storm water focus on the 405 ``urbanized areas'' identified by the Bureau of the Census. The Report further found that a number of discharges from unregulated industrial facilities warranted further investigation to determine the need for regulation. It classified these unregulated industrial discharges in two groups: Group A and Group B. Group A comprised sources that may be considered a high priority for inclusion in the NPDES program for storm water because discharges from these sources are similar or identical to already regulated sources. These ``look alike'' storm water discharge sources were not covered in the initial NPDES regulations for storm water due to the language used to define ``associated with industrial activity.'' In the initial regulations for storm water, ``industrial activity'' is identified using Standard Industrial Classification (SIC) codes. The use of SIC codes led to incomplete categorization of industrial activities with discharges that needed to be regulated to protect water quality. Group B consisted of 18 industrial sectors, which included sources that EPA expected to contribute to storm water contamination due to the activities conducted and pollutants anticipated onsite (e.g., vehicle maintenance, machinery and electrical repair, and intensive agricultural activities).

EPA reported on the latter component of the section 402(p)(5) study via President Clinton's Clean Water Initiative, which was released on February 1, 1994 (U.S. Environmental Protection Agency, Office of Water. 1994. President Clinton's Clean Water Initiative. Washington, D.C. EPA 800-R-94-001) (``Initiative''). The Initiative addressed a number of issues associated with NPDES requirements for storm water discharges and proposed (1) establishing a phased compliance with a water quality standards approach for discharges from municipal separate storm sewer systems with priority on controlling discharges from municipal growth and development areas, (2) clarifying that the maximum extent practicable standard should be applied in a site-specific, flexible manner, taking into account cost considerations as well as water quality effects, (3) providing an exemption from the NPDES program for storm water discharges from industrial facilities with no activities or significant materials exposed to storm water, (4) providing extensions to the statutory deadlines to complete implementation of the NPDES program for the storm water program, (5) targeting urbanized areas for the requirements in the NPDES program for storm water, and (6) providing control of discharges from inactive and abandoned mines located on Federal lands in a more targeted, flexible manner. Additionally, prior to promulgation of today's rule, section 431 of the Agency's Appropriation Act for FY 2000 (Departments of Veterans Affairs and Housing and Urban Development and Independent Agencies Appropriations Act of 2000, Public Law 106-74, section 432 (1999)) directed EPA to report on certain matters to be covered in today's rule. That report supplements the study required by CWA Section 402(p)(5). EPA is publishing the availability of that report elsewhere in this issue of the Federal Register.

Several commenters asserted that the Report to Congress is an inadequate basis for the designation and regulation of sources covered under today's final rule, specifically the nationwide designation of small municipal separate storm sewer systems within urbanized areas and construction activities disturbing between one and five acres.

EPA believes that it has developed an adequate record for today's regulation both through the Report to Congress and the Clean Water Initiative and through more recent activities, including the FACA Subcommittee process, regulatory notices and evaluation of comments, and recent research and analysis. EPA does not interpret the congressional reporting requirements of CWA section 402(p)(5) to be the sole basis for determining sources to be regulated under today's final rule.

EPA's decision to designate on a national basis small MS4s in urbanized areas is supported by studies that clearly show a direct correlation between urbanization and adverse water quality impacts from storm water discharges. (Schueler, T. 1987. Controlling Urban Runoff: A Practical Manual for Planning & Designing Urban BMPs. Metropolitan Washington Council of Governments). ``Urbanized areas''--within which all small MS4s would be covered--represent the most intensely developed and dense areas of the Nation. They constitute only two percent of the land area but 63 percent of the total population. See section I.B.1, Urban Development, above, for studies and assessments of the link between urban development and storm water impacts on water resources.

Commenters argued that the Report to Congress does not address storm water discharges from construction sites. They further argued that the designation of small construction sites per today's final rule goes beyond the President's 1994 Initiative because the Initiative only recommends requiring municipalities to implement a storm water management program to control unregulated storm water sources, ``including discharges from construction of less than 5 acres, which are part of growth, development and significant redevelopment activities.'' They point out that the Initiative provides that unregulated storm water discharges not addressed through a municipal program would not be covered by the NPDES program. Commenters assert that EPA has not developed a record independent of its section 402(p)(5) studies that demonstrates the necessity of regulating under a separate NPDES permit storm water discharges from smaller construction sites ``to protect water quality.'' EPA disagrees.

EPA evaluated the nature and extent of pollutants from construction site sources in a process that was separate and distinct from the development of the Report to Congress. Today's decision to regulate certain storm water discharges from construction sites disturbing less than 5 acres arose in part

[[Page 68733]]

out of the 9th Circuit remand in NRDC v. EPA, 966 F.2d 1292 (9th Cir. 1992). In that case, the court remanded portions of the Phase I storm water regulations related to discharges from construction sites. Those regulations define ``storm water discharges associated with industrial activity'' to include only those storm water discharges from construction sites disturbing 5 acres or more of total land area (see 40 CFR 122.26(b)(14)(x)). In its decision, the court concluded that the 5-acre threshold was improper because the Agency had failed to identify information ``to support its perception that construction activities on less than 5 acres are non-industrial in nature'' (966 F.2d at 1306). The court remanded the below 5 acre exemption to EPA for further proceedings (966 F.2d at 1310).

In a Federal Register notice issued on December 18, 1992, EPA noted that it did not believe that the Court's decision had the effect of automatically subjecting small construction sites to the existing application requirements and deadlines. EPA believed that additional notice and comment were necessary to clarify the status of these sites. The information received during the notice and comment process and additional research, as discussed in section I.B.3 Construction Site Runoff, formed the basis for the designation of construction activity disturbing between one and five acres on a nationwide basis. EPA's objectives in today's proposal include an effort to (1) address the 9th Circuit remand, (2) address water quality concerns associated with construction activities that disturb less than 5 acres of land, and (3) balance conflicting recommendations and concerns of stakeholders.

One commenter noted that EPA's proposal would fail to regulate industrial facilities identified as Group A and Group B in the March 1995 Report to Congress. EPA is relying on the analysis in the Report, which provided that the recommendation for coverage was meant as guidance and was not intended to be an identification of specific categories that must be regulated under Section 402(p)(6). Report to Congress, p. 4-1. The Report recognized the existence of limited data on which to base loadings estimates to support the nationwide designation of individual or categories of sources. Report to Congress, p. 4-44. Furthermore, during FACA Subcommittee discussion, EPA continued to urge stakeholders to provide further data relating to industrial and commercial storm water sources, which EPA did not receive. EPA concluded that, due to insufficient data, these sources were not appropriate for nationwide designation at this time.

E. Industrial Facilities Owned or Operated by Small Municipalities

Congress granted extensions to the NPDES permit application process for selected classes of storm water discharges associated with industrial activity. On December 18, 1991, Congress enacted the Intermodal Surface Transportation Efficiency Act (ISTEA), which postponed NPDES permit application deadlines for most storm water discharges associated with industrial activity at facilities that are owned or operated by small municipalities. EPA and States authorized to administer the NPDES program could not require any municipality with a population of less than 100,000 to apply for or obtain an NPDES permit for any storm water discharge associated with industrial activity prior to October 1, 1992, except for storm water discharges from airports, power plants, or uncontrolled sanitary landfills. See 40 CFR 122.26(e)(1); 57 FR 11524, April 2, 1992 (reservation of NPDES application deadlines for ISTEA facilities).

The facilities exempted by ISTEA discharge storm water in the same manner (and are expected to use identical processes and materials) as the industrial facilities regulated under the 1990 Phase I regulations. Accordingly, these facilities pose similar water quality problems. The extended moratorium for these facilities was necessary to allow municipalities additional time to comply with NPDES requirements. The proposal for today's rule would have maintained the existing deadline for seeking coverage under an NPDES permit (August 7, 2001).

Today's rule changes the permit application deadline for such municipally owned or operated facilities discharging industrial storm water to make it consistent with the application date for small regulated MS4s. Because EPA missed its March 1999 deadline for promulgating today's rule, and the deadline for MS4s to submit permit applications has been extended to three years and 90 days from the date of this notice, the deadline for permitting ISTEA sources has been similarly extended. The permitting of these sources is discussed below in section ``II.I.3. ISTEA Sources.''

F. Related Nonpoint Source Programs

Today's rule addresses point source discharges of storm water runoff and non-storm water discharges into MS4s. Many of these sources have been addressed by nonpoint source control programs, which are described briefly below.

In 1987, section 319 was added to the CWA to provide a framework for funding State and local efforts to address pollutants from nonpoint sources not addressed by the NPDES program. To obtain funding, States are required to submit Nonpoint Source Assessment Reports identifying State waters that, without additional control of nonpoint sources of pollution, could not reasonably be expected to attain or maintain applicable water quality standards or other goals and requirements of the CWA. States are also required to prepare and submit for EPA approval a statewide Nonpoint Source Management Program for controlling nonpoint source water pollution to navigable waters within the State and improving the quality of such waters. State program submittals must identify specific best management practices (BMPs) and measures that the State proposes to implement in the first four years after program submission to reduce pollutant loadings from identified nonpoint sources to levels required to achieve the stated water quality objectives.

State nonpoint source programs funded under section 319 can include both regulatory and nonregulatory State and local approaches. Section 319(b)(2)(B) specifies that a combination of ``nonregulatory or regulatory programs for enforcement, technical assistance, financial assistance, education, training, technology transfer, and demonstration projects' may be used, as necessary, to achieve implementation of the BMPs or measures identified in the section 319 submittals.

Section 6217 of the Coastal Zone Act Reauthorization Amendments (CZARA) of 1990 provides that States with approved coastal zone management programs must develop coastal nonpoint pollution control programs and submit them to EPA and the National Oceanic and Atmospheric Administration (NOAA) for approval. Failure to submit an approvable program will result in a reduction of Federal grants under both the Coastal Zone Management Act and section 319 of the CWA.

State coastal nonpoint pollution control programs under CZARA must include enforceable policies and mechanisms that ensure implementation of the management measures throughout the coastal management area. EPA issued Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters under section 6217(g) in

[[Page 68734]]

January 1993. The guidance identifies management measures for five major categories of nonpoint source pollution. The management measures reflect the greatest degree of pollutant reduction that is economically achievable for each of the listed sources. These management measures provide reference standards for the States to use in developing or refining their coastal nonpoint programs. A few management measures, however, contain quantitative standards that specify pollutant loading reductions. For example, the New Development Management Measure, which is applicable to construction in urban areas, requires (1) that by design or performance the average annual total suspended solid loadings be reduced by 80 percent and (2) to the extent practicable, that the pre-development peak runoff rate and average volume be maintained.

EPA and NOAA published Coastal Nonpoint Pollution Control Program: Program Development and Approval Guidance (1993). The document clarifies that States generally must implement management measures for each source category identified in the EPA guidance developed under section 6217(g). Coastal Nonpoint Pollution Control Programs are not required to address sources that are clearly regulated under the NPDES program as point source discharges. Specifically, such programs would not need to address small MS4s and construction sites covered under NPDES storm water permits (both general and individual).

II. Description of Program

A. Overview

1. Objectives EPA Seeks To Achieve in Today's Rule

EPA seeks to achieve several objectives in today's final rule. First, EPA is implementing the requirement under CWA section 402(p)(6) to provide a comprehensive storm water program that designates and controls additional sources of storm water discharges to protect water quality. Second, EPA is addressing storm water discharges from the activities exempted under the 1990 storm water permit application regulations that were remanded by the Ninth Circuit Court of Appeals in NRDC v. EPA, 966 F.2d 1292 (9th Circuit, 1992). These are construction activities disturbing less than 5 acres and so-called ``light'' industrial activities not exposed to storm water (see discussion of ``no exposure'' below). Third, EPA is providing coverage for the so-called ``donut holes'' created by the existing NPDES storm water program. Donut holes are geographic gaps in the NPDES storm water program's regulatory scheme. They are MS4s located within areas covered by the existing NPDES storm water program, but not currently addressed by the storm water program because it is based on political jurisdictions. Finally, EPA also is trying to promote watershed planning as a framework for implementing water quality programs where possible.

Although EPA had options for different approaches (see alternatives discussed in the January 9, 1998, proposed regulation), EPA believes it can best achieve its objectives through flexible innovations within the framework of the NPDES program. Unlike the interim section 402(p)(6) storm water regulations EPA promulgated in 1995, EPA no longer designates all of the unregulated storm water discharges for nationwide coverage under the NPDES program for storm water. The framework for today's final rule is one that balances automatic designation on a nationwide basis and locally-based designation and waivers. Nationwide designation applies to those classes or categories of storm water discharges that EPA believes present a high likelihood of having adverse water quality impacts, regardless of location. Specifically, today's rule designates discharges from small MS4s located in urbanized areas and storm water discharges from construction activities that result in land disturbance equal to or greater than one and less than five acres. As noted under Section I.B., Water Quality Concerns/ Environmental Impact Studies and Assessments, these two categories of storm water sources, when unregulated, tend to cause significant adverse water quality impacts. Additional sources are not covered on a nationwide basis either because EPA currently lacks information indicating a consistent potential for adverse water quality impact or because EPA believes that the likelihood of adverse impacts on water quality is low, with some localized exceptions. Additional individual sources or categories of storm water discharges could, however, be covered under the program through a local designation process. A permitting authority may designate additional small MS4s after developing designation criteria and applying those criteria to small MS4s located outside of an urbanized area, in particular those with a population of 10,000 or more and a population density of at least 1,000. Exhibit 1 illustrates the designation framework for today's final rule.

BILLING CODE 6560-50-P

[[Page 68735]]

[GRAPHIC] [TIFF OMITTED] TR08DE99.000

BILLING CODE 6560-50-C

[[Page 68736]]

The designation framework for today's final rule provides a significant degree of flexibility. The proposed provisions for nationwide designation of storm water discharges from construction and from small MS4s in urbanized areas allowed for a waiver of applicable requirements based on appropriate water quality conditions. Today's final rule expands and simplifies those waivers.

The permitting authority may waive the requirement for a permit for any small MS4 serving a jurisdiction with a population of less than 1,000 unless storm water controls are needed because the MS4 is contributing to a water quality impairment. The permitting authority may also waive permit coverage for MS4s serving a jurisdiction with a population of less than 10,000 if all waters that receive a discharge from the MS4 have been evaluated and discharges from the MS4 do not significantly contribute to a water quality impairment or have the potential to cause an impairment. Today's rule also allows States with a watershed permitting approach to phase in coverage for MS4s in jurisdictions with populations under 10,000.

Water quality conditions are also the basis for a waiver of requirements for storm water discharges from construction activities disturbing between one and five acres. For these small construction sources, the rule provides significant flexibility for waiving otherwise applicable regulatory requirements where a permitting authority determines, based on water quality and watershed considerations, that storm water discharge controls are not needed.

Coverage can be extended to municipal and construction sources outside the nationwide designated classes or categories based on watershed and case-by-case assessments. For the municipal storm water program, today's rule provides broad discretion to NPDES permitting authorities to develop and implement criteria for designating storm water discharges from small MS4s outside of urbanized areas. Other storm water discharges from unregulated industrial, commercial, and residential sources will not be subject to the NPDES permit requirements unless a permitting authority determines on a case-by-case basis (or on a categorical basis within identified geographic areas such as a State or watershed) that regulatory controls are needed to protect water quality. EPA believes that the flexibility provided in today's rule facilitates watershed planning.

2. General Requirements for Regulated Entities Under Today's Rule

As previously noted, today's final rule defines additional classes and categories of storm water discharges for coverage under the NPDES program. These designated dischargers are required to seek coverage under an NPDES permit. Furthermore, all NPDES-authorized States and Tribes are required to implement these provisions and make any necessary amendments to current State and Tribal NPDES regulations to ensure consistency with today's final rule. EPA remains the NPDES permitting authority for jurisdictions without NPDES authorization.

Today's final rule includes some new requirements for NPDES permitting authorities implementing the CWA section 402(p)(6) program. EPA has made a significant effort to build flexibility into the program while attempting to maintain an appropriate level of national consistency. Permitting authorities must ensure that NPDES permits issued to MS4s include the minimum control measures established under the program. Permitting authorities also have the ability to make numerous decisions including who is regulated under the program, i.e., case-by-case designations and waivers, and how responsibilities should be allocated between regulated entities.

Today's final rule extends the NPDES program to include discharges from the following: small MS4s within urbanized areas (with the exception of systems waived from the requirements by the NPDES permitting authority); other small MS4s meeting designation criteria to be established by the permitting authority; and any remaining MS4 that contributes substantially to the storm water pollutant loadings of a physically interconnected MS4 already subject to regulation under the NPDES program. Small MS4s include urban storm sewer systems owned by Tribes, States, political subdivisions of States, as well as the United States, and other systems located within an urbanized area that fall within the definition of an MS4. These include, for example, State departments of transportation (DOTs), public universities, and federal military bases.

Today's final rule requires all regulated small MS4s to develop and implement a storm water management program. Program components include, at a minimum, 6 minimum measures to address: public education and outreach; public involvement; illicit discharge detection and elimination; construction site runoff control; post-construction storm water management in new development and redevelopment; and pollution prevention and good housekeeping of municipal operations. These program components will be implemented through NPDES permits. A regulated small MS4 is required to submit to the NPDES permitting authority, either in its notice of intent (NOI) or individual permit application, the BMPs to be implemented and the measurable goals for each of the minimum control measures listed above.

The rule addresses all storm water discharges from construction site activities involving clearing, grading and excavating land equal to or greater than 1 acre and less than 5 acres, unless requirements are otherwise waived by the NPDES permitting authority. Discharges from such sites, as well as construction sites disturbing less than 1 acre of land that are designated by the permitting authority, are required to implement requirements set forth in the NPDES permit, which may reference the requirements of a qualifying local program issued to cover such discharges.

The rule also addresses certain other sources regulated under the existing NPDES program for storm water. For municipally-owned industrial sources required to be regulated under the existing NPDES storm water program but exempted from immediate compliance by the Intermodal Surface Transportation Act of 1991 (ISTEA), the rule revises the existing deadline for seeking coverage under an NPDES permit (August 7, 2001) to make it consistent with the application date for small regulated MS4s. (See section I.3. below.) The rule also provides relief from NPDES storm water permitting requirements for industrial sources with no exposure of industrial materials and activities to storm water.

3. Integration of Today's Rule With the Existing Storm Water Program

In developing an approach for today's final rule, numerous early interested stakeholders encouraged EPA to seek opportunities to integrate, where possible, the proposed Phase II requirements with existing Phase I requirements, thus facilitating a unified storm water discharge control program. EPA believes that this objective is met by using the NPDES framework. This framework is already applied to regulated storm water discharge sources and is extended to those sources designated under today's rule. This approach facilitates program consistency, public access to information, and program oversight.

[[Page 68737]]

EPA believes that today's final rule provides consistency in terms of program coverage and requirements for existing and newly designated sources. For example, the rule includes most of the municipal donut holes, those MS4s located in incorporated places, townships or towns with a population under 100,000 that are within Phase I counties. These MS4s are not addressed by the existing NPDES storm water program while MS4s in the surrounding county are currently addressed. In addition, the minimum control measures required in today's rule for regulated small MS4s are very similar to a number of the permit requirements for medium and large MS4s under the existing storm water program. Following today's rule, permit requirements for all regulated MS4s (both those under the existing program and those under today's rule) will require implementation of BMPs. Furthermore, with regard to the development of NPDES permits to protect water quality, EPA intends to apply the August 1, 1996, Interim Permitting Approach for Water Quality-Based Effluent Limitations in Storm Water Permits (hereinafter, ``Interim Permitting Approach'') (see Section II.L.1. for further description) to all MS4s covered by the NPDES program.

EPA is applying NPDES permit requirements to construction sites below 5 acres that are similar to the existing requirements for those above 5 acres and above. In addition, today's rule allows compliance with qualifying local, Tribal, or State erosion and sediment controls to meet the erosion and sediment control requirements of the general permits for storm water discharges associated with construction, both above and below 5 acres.

4. General Permits

EPA recommends using general permits for all newly regulated storm water sources under today's rule. The use of general permits, instead of individual permits, reduces the administrative burden on permitting authorities, while also limiting the paperwork burden on regulated parties seeking permit authorization. Permitting authorities may, of course, require individual permits in some cases to address specific concerns, including permit non-compliance.

EPA recommends that general permits for MS4s, in particular, be issued on a watershed basis, but recognizes that each permitting authority must decide how to develop its general permit(s). Permit conditions developed to address concerns and conditions of a specific watershed could reflect a watershed plan; such permit conditions must provide for attainment of applicable water quality standards (including designated uses), allocations of pollutant loads established by a TMDL, and timing requirements for implementation of a TMDL. If the permitting authority issues a State-wide general permit, the permitting authority may include separate conditions tailored to individual watersheds or urbanized areas. Of course, for a newly regulated MS4, modification of an existing individual MS4 permit to include the newly regulated MS4 as a ``limited co-permittee'' also remains an option.

5. Tool Box

During the FACA process, many Storm Water Phase II FACA Subcommittee representatives expressed an interest, which was endorsed by the full Committee, in having EPA develop a ``tool box'' to assist States, Tribes, municipalities, and other parties involved in the Phase II program. EPA made a commitment to work with Storm Water Phase II FACA Subcommittee representatives in developing such a tool box, with the expectation that a tool box would facilitate implementation of the storm water program in an effective and cost-efficient manner. EPA has developed a preliminary working tool box (available on EPA's web page at www.epa.gov/owm/sw/toolbox). EPA intends to have the tool box fully developed by the time of the first general permits. EPA also intends to update the tool box as resources and data become available. The tool box will include the following eight main components: fact sheets; guidances; a menu of BMPs for the six MS4 minimum measures; an information clearinghouse; training and outreach efforts; technical research; support for demonstration projects; and compliance monitoring/assistance tools. EPA intends to issue the menu of BMPs, both structural and non-structural, by October 2000. In addition, EPA will issue by October 2000 a ``model'' permit and will issue by October 2001 guidance materials on the development of measurable goals for municipal programs.

In an attempt to avoid duplication, the Agency has undertaken an effort to identify and coordinate sources of information that relate to the storm water discharge control program from both inside and outside the Agency. Such information includes research and demonstration projects, grants, storm water management-related programs, and compendiums of available documents, including guidances, related directly or indirectly to the comprehensive NPDES storm water program. Based on this effort, EPA is developing a tool box containing fact sheets and guidance documents pertaining to the overall program and rule requirements (e.g., guidance on municipal and construction programs, and permitting authority guidance on designation and waiver criteria); models of current programs aimed at assisting States, Tribes, municipalities, and others in establishing programs; a comprehensive list of reference documents organized according to subject area (e.g., illicit discharges, watersheds, water quality standards attainment, funding sources, and similar types of references); educational materials; technical research data; and demonstration project results. The information collected by EPA will not only provide the background for tool box materials, but will also be made available through an information clearinghouse on the world wide web.

With assistance from EPA, the American Public Works Association (APWA) developed a workbook and series of workshops on the proposed Phase II rule. Ten workshops were held from September 1998 through May 1999. Depending on available funding, these workshops may continue after publication of today's final rule. EPA also intends to provide training to enable regional offices to educate States, Tribes, and municipalities about the storm water program and the availability of the tool box materials.

The CWA currently provides funding mechanisms to support activities related to storm water. These mechanisms will be described in the tool box. Activities funded under grant and loan programs, which could be used to assist in storm water program development, include programs in the nonpoint source area, storm water demonstration projects, source water protection and wastewater construction projects. EPA has already provided funding for numerous research efforts in these areas, including a database of BMP effectiveness studies (described below), an assessment of technologies for storm water management, a study of the effectiveness of storm water BMPs for controlling the impacts of watershed imperviousness, protocols for wet weather monitoring, development of a dynamic model for wet weather flows, and numerous outreach projects.

EPA has entered into a cooperative agreement with the Urban Water Resources Research Council of the American Society of Civil Engineers (ASCE) to develop a scientifically-based management tool for the information

[[Page 68738]]

needed to evaluate the effectiveness of urban storm water runoff BMPs nationwide. The long-term goal of the National Stormwater BMP Database project is to promote technical design improvements for BMPs and to better match their selection and design to the local storm water problems being addressed. The project team has collected and evaluated hundreds of existing published BMP performance studies and created a database covering about 75 test sites. The database includes detailed information on the design of each BMP and its watershed characteristics, as well as its performance. Eventually the database will include the nationwide collection of information on the characteristics of structural and non-structural BMPs, data collection efforts (e.g., sampling and flow gaging equipment), climatological characteristics, watershed characteristics, hydrologic data, and constituent data. The database will continue to grow as new BMP data become available. The initial release of the database, which includes data entry and retrieval software, is available on CD-ROM and operates on Windows -compatible personal computers. The ASCE project team envisions that periodic updates to the database will be distributed through the Internet. The team is currently developing a system for Internet retrieval of selected database records, and this system is expected to be available in early 2000.

EPA and ASCE invite BMP designers, owners and operators to participate in the continuing database development effort. To make this effort successful, a large database is essential. Interested persons are encouraged to submit their BMP performance evaluation data and associated BMP watershed characteristics for potential entry into the database. The software included in the CD-ROM allows data providers to enter their BMP data locally, retain and edit the data as needed, and submit them to the ASCE Database Clearinghouse when ready.

To obtain a copy of the database, please contact Jane Clary, Database Clearinghouse Manager, Wright Water Engineers, Inc., 2490 W. 26th Ave., Suite 100A, Denver, CO 80211; Phone 303-480-1700; E-mail clary@wrightwater.com.

In addition, EPA requests that researchers planning to conduct BMP performance evaluations compile and collect BMP reporting information according to the standard format developed by ASCE. The format is provided with the database software and is also available on the ASCE website at www.asce.org/peta/tech/nsbd01.html.

6. Deadlines Established in Today's Action

Exhibit 2 outlines the various deadlines established under today's final rule. EPA believes that the dates allow sufficient time for completion of both the NPDES permitting authority's and the permittee's program responsibilities.

Exhibit 2-Storm Water Phase II Actions Deadlines

Activity	Deadline date
NPDES-authorized States modify NPDES program if no statutory change is required.	1 year from date of publication of today's rule in the Federal Register.
NPDES-authorized States modify NPDES program if statutory change is required.	2 years from date of publication of today's rule in the Federal Register.
EPA issues a menu of BMPs for regulated small MS4s.	October 27, 2000
ISTEA sources submit permit application	3 years and 90 days from date

	of publication of today's rule in the Federal Register.
Permitting authority issues general permit(s) (if this type of permit coverage is selected).	3 years from date of publication of today's rule in the Federal Register.
Regulated small MS4s submit permit application:	
a. If designated under Sec. 122.32(a)(1) unless the permitting authority has established a phasing schedule under Sec. 123.35(d)(3).	a. 3 years and 90 days from date of publication of today's rule in the Federal Register.
b. If designated under Sec. 122.32(a)(2) or Secs. 122.26(a)(9)(i) (C) or (D).	b. Within 180 days of notice.
Storm water discharges associated with small construction activity submit permit application:	
a. If designated under Sec. 122.26(b)(15)(i).	a. 3 years and 90 days from date of publication of today's rule in the Federal Register
b. If designated under Sec. 122.26(b)(15)(ii).	b. Within 180 days of notice.
Permitting authority designates small MS4s under Sec. 123.35(b)(2).	3 years from date of publication of today's rule in the Federal Register or 5 years from date of publication of today's rule in the Federal Register if a watershed plan is in place
Regulated small MS4s' program fully developed and implemented.	Up to 5 years from date of permit issuance.
Reevaluation of the municipal storm water rules by EPA.	13 years from date of publication of today's rule in the Federal Register
Permitting authority determination on a petition.	Within 180 days of receipt.
Non-municipal sources designated under Sec. 122.26(a)(9)(i) (C) or (D) submit permit application.	Within 180 days of notice.
Submission of No Exposure Certification	Every 5 years.

B. Readable Regulations

Today, EPA is finalizing new regulations in a ``readable regulation'' format. This reader-friendly, plain language approach is a departure from traditional regulatory language and should enhance the rule's readability. These plain language regulations use questions and answers, ``you'' to identify the person who must comply, and terms like ``must'' rather than ``shall'' to identify a mandate. This new format, which minimizes layers of subparagraphs, should also allow the reader to easily locate specific provisions of the regulation.

Some sections of today's final rule are presented in the traditional language and format because these sections amend existing regulations. The readable regulation format was not used in these existing provisions in an attempt to avoid confusion or disruption

[[Page 68739]]

of the readability of the existing regulations.

Most commenters supported EPA's use of plain language and agreed with EPA that the question and answer format makes the rule easier to understand. Three commenters thought that EPA should retain the traditional rule format. The June 1, 1998, Presidential memorandum directs all government agencies to write documents in plain language. Based on the majority of the comments, EPA has retained the plain language format used in the January 9, 1998, proposal in today's final rule.

The proposal to today's final rule included guidance as well as legal requirements. The word ``must'' indicates a requirement. Words like ``should,'' ``could,'' or ``encourage'' indicate a recommendation or guidance. In addition, the guidance was set off in parentheses to distinguish it from requirements.

EPA received numerous comments supporting the inclusion of guidance in the text of the Code of Federal Regulations (CFR), as well as comments opposing inclusion of guidance. Supporters stated that preambles and guidance documents are often not accessible when rules are implemented. Any language not included in the CFR is therefore not available when it may be most needed. Commenters that opposed including guidance in the CFR expressed the concern that any language in the rule might be interpreted as a requirement, in spite of any clarifying language. They suggested that guidance be presented in the preamble and additional guidance documents.

The majority of commenters on this issue thought that the guidance should be retained but the distinction between requirements and guidance should be better clarified. Suggestions included clarifying text, symbols, and a change from use of the word ``should'' to ``EPA recommends'' or ``EPA suggests''. EPA believes that it is important to include the guidance in the rule and agrees that the distinction between requirements and EPA recommendations must be very clear. In today's final rule, EPA has put the guidance in paragraphs entitled ``Guidance'' and replaced the word ``should'' with ``EPA recommends.'' This is intended to clarify that the recommendations contained in the guidance paragraphs are not legally binding.

C. Program Framework: NPDES Approach

Today's rule regulates Phase II sources using the NPDES permit program. EPA interprets Clean Water Act section 402(p)(6) as authorizing the Agency to develop a storm water program for Phase II sources either as part of the existing NPDES permit program or as a stand alone non-NPDES program such as a self-implementing rule. Under either approach, EPA interprets section 402(p)(6) as directing EPA to publish regulations that ``regulate'' the remaining unregulated sources, specifically to establish requirements that are federally enforceable under the CWA. Although EPA believes that it has the discretion to not require sources regulated under CWA section 402(p)(6) to be covered by NPDES permits, the Agency has determined, for the reasons discussed below, that it is most appropriate to use NPDES permits in implementing the program to address the sources designated for regulation in today's rule.

As discussed in Section II.A, Overview, EPA sought to achieve certain goals in today's final rule. EPA believes that the NPDES program best achieves EPA's goals for today's final rule for the reasons discussed below.

Requiring Phase II sources to be covered by NPDES permits helps address the consistency problems currently caused by municipal ``donut holes.'' Donut holes are gaps in program coverage where a small unregulated MS4 is located next to or within a regulated larger MS4 that is subject to an NPDES permit under the Phase I NPDES storm water program. The existence of such ``donut holes'' creates an equity problem because similar discharges may remain unregulated even though they cause or contribute to the same adverse water quality impacts. Using NPDES permits to regulate the unregulated discharges in these areas is intended to facilitate the development of a seamless regulatory program for the mitigation and control of contaminated storm water discharges in an urbanized area. For example, today's rule allows a newly regulated MS4 to join as a ``limited'' co-permittee with a regulated MS4 by referencing a common storm water management program. Such cooperation should be further encouraged by the fact that the minimum control measures required in today's rule for regulated small MS4s are very similar to a number of the permit requirements for medium and large MS4s under the Phase I storm water program. The minimum control measures applicable to discharges from smaller MS4s are described with slightly more generality than under the Phase I permit application regulations for larger MS4s, thus enabling maximum flexibility for operators of smaller MS4s to optimize efforts to protect water quality.

Today's rule also applies NPDES permit requirements to construction sites below 5 acres that are similar to the existing requirements for those 5 acres and above. In addition, the rule would allow compliance with qualifying local, Tribal, or State erosion and sediment controls to meet the erosion and sediment control requirements of the general permits for storm water discharges associated with construction, both above and below 5 acres.

Incorporating the CWA section 402(p)(6) program into the NPDES program capitalizes upon the existing governmental infrastructure for administration of the NPDES program. Moreover, much of the regulated community already understands the NPDES program and the way it works.

Another goal of the NPDES program approach is to provide flexibility in order to facilitate and promote watershed planning and sensitivity to local conditions. NPDES permits promote those goals in several ways. NPDES general permits may be used to cover a category of regulated sources on a watershed basis or within political boundaries. The NPDES permitting process provides a mechanism for storm water controls tailored on a case-by-case basis, where necessary. In addition, the NPDES permit requirements of a permittee may be satisfied by another cooperating entity. Finally, NPDES permits may incorporate the requirements of existing State, Tribal and local programs, thereby accommodating State and Tribes seeking to coordinate the storm water program with other programs, including those that focus on watershed-based nonpoint source regulation.

In promoting the watershed approach to program administration, EPA believes NPDES general permits can cover a category of dischargers within a defined geographic area. Areas can be defined very broadly to include political boundaries (e.g., county), watershed boundaries, or State or Tribal land.

NPDES permits generally require an application or a notice of intent(NOI) to trigger coverage. This information exchange assures communication between the permitting authority and the regulated community. This communication is critical in ensuring that the regulated community is aware of the requirements and the permitting authority is aware of the potential for adverse impacts to water quality from identifiable locations. The NPDES permitting process includes the public as a valuable stakeholder and ensures

[[Page 68740]]

that the public is included and information is made publicly available.

Another concern for EPA and several stakeholders was that the program ensure citizen participation. The NPDES approach ensures opportunities for citizen participation throughout the permit issuance process, as well as in enforcement actions. NPDES permits are also federally enforceable under the CWA.

EPA believes that the use of NPDES permits makes a significant difference in the degree of compliance with regulations in the storm water program. The NPDES program provides for public participation in the development, enforcement and revision of storm water management programs. Citizen suit enforcement has assisted in focusing attention on adverse water quality impacts on a localized, public priority basis. Citizens frequently rely on the NPDES permitting process and the availability of NOIs to track program implementation and help them enforce regulatory requirements.

NPDES permits are also advantageous to the permittee. The NPDES permit informs the permittee about the scope of what it is expected do to be in compliance with the Clean Water Act. As explained more fully in EPA's April 1995 guidance, Policy Statement on Scope of Discharge Authorization and Shield Associated with NPDES Permits, compliance with an NPDES permit constitutes compliance with the Clean Water Act (see CWA section 402(k)). In addition, NPDES permittees are excluded from duplicative regulatory regimes under the Resource Conservation and Recovery Act and the Comprehensive Emergency Response, Compensation and Liability Act under RCRA's exclusions to the definition of ``solid waste'' and CERCLA's exemption for ``federally permitted releases.''

EPA considered suggestions that the Agency authorize today's rule to be implemented as a self-implementing rule. This would be a regulation promulgated at the Federal, State, or Tribal level to control some or all of the storm water dischargers regulated under today's rule. Under this approach, a rule would spell out the specific requirements for dischargers and impose the restrictions and conditions that would otherwise be contained in an NPDES permit. It would be effective until modified by EPA, a State, or a Tribe, unlike an NPDES permit which cannot exceed a duration of five years. Some stakeholders believed that this approach would reduce the burden on the regulated community (e.g., by not requiring permit applications), and considerably reduce the amount of additional paperwork, staff time and accounting required to administer the proposed permit requirements.

EPA is sensitive to the interest of some stakeholders in having a streamlined program that minimizes the burden associated with permit administration and maximizes opportunities for field time spent by regulatory authorities. Key provisions in today's rule address some of these concerns by promoting a streamlined approach to permit issuance by, for example, using general permits and allowing the incorporation of existing programs. By adopting the NPDES approach rather than a self-implementing rule, today's rule also allows for consistent regulation between larger MS4s and construction sites regulated under the existing storm water management rule and smaller sources regulated under today's rule.

EPA believes that it is most appropriate to use NPDES permits to implement a program to address the sources regulated by today's rule. In addition to the reasons discussed above, NPDES permits provide a better mechanism than would a self-implementing rule for tailoring storm water controls on a case-by-case basis, where necessary. One commenter reasoned this concern could be addressed by including provisions in the regulation that allow site-specific BMPs (i.e., case-by-case permits), suggesting storm water discharges that might require site-specific BMPs can be identified during the designation process of the regulatory authority. EPA believes that, in addition to its complexity, the commenter's approach lacks the other advantages of the

NPDES permitting process.

A self-implementing rule would not ensure the degree of public participation that the NPDES permit process provides for the development, enforcement and revision of the storm water management program. A self-implementing rule also might not have provided the regulated community the ``permit shield'' under CWA section 402(k) that is provided by an NPDES permit. Based on all these considerations, EPA declined to adopt a self-implementing rule approach and adopted the NPDES approach.

Some State representatives sought alternative approaches for State implementation of the storm water program for Phase II sources. These State representatives asserted that a non-NPDES alternative approach best facilitated watershed management and avoided duplication and overlapping regulations. These representatives believed the NPDES approach would undercut State programs that had developed storm water controls tailored to local watershed concerns. Finally, a number of commenters expressed the view that States implement a variety of programs not based on the CWA that are effective in controlling storm water, and that EPA should provide incentives for their implementation and improvement in performance.

Throughout the development of the rule, State representatives sought alternatives to the NPDES approach for State implementation of the storm water program for Phase II sources. Discussions focused on an approach whereby States could develop an alternative program that EPA would approve or disapprove based on identified criteria, including that the alternative non-NPDES program would result in ``equivalent or better protection of water quality.'' The State representatives, however, were unable to propose or recommend criteria for gauging whether a program would provide equivalent protection. EPA also did not receive any suggestions for objective, workable criteria in response to the Agency's explicit request for specific criteria (by which EPA could objectively judge such programs) in the preamble to the proposed rule.

EPA evaluated several existing State initiatives to address storm water and found many cases where standards under State programs may be coordinated with the Federal storm water program. Where the NPDES permit is developed in coordination with State standards, there are opportunities to avoid duplication and overlapping requirements. Under today's rule, an NPDES permitting authority may include conditions in the NPDES permit that direct an MS4 to follow the requirements imposed under State standards, rather than the requirements of Sec. 122.34(b). This is allowed as long as the State program at a minimum imposes the relevant requirements of Sec. 122.34(b). Additional opportunities follow from other provisions in today's rule.

Seeking to further explore the feasibility of a non-NPDES approach, the Agency, after the proposal, had extensive discussions with representatives of a number of States. Discussions related specifically to possible alternatives for regulations of urban storm water discharges and MS4s specifically. The Agency also sought input on these issues from other stakeholders.

As a result of these discussions, many of the commenters provided input on issues such as: whether or not the Agency should require NPDES permits; whether location of MS4s in urbanized

[[Page 68741]]

areas should be the basis for designation or whether designation should be based on other determinations relating to water quality; whether States should be allowed to satisfy the conditions of the rule through the use of existing State programs; and issues concerning timing and resources for program implementation.

In response, today's rule still follows the regulatory scheme of the proposed rule, but incorporates additional flexibility to address some of the concerns raised by commenters.

In order to facilitate implementation by States that utilize a watershed permitting approach or similar approach (i.e., based on a State's unified watershed assessments), today's rule allows States to phase in coverage for MS4s in jurisdictions with a population less than 10,000. Under such an approach, States could focus their resources on a rolling basis to assist smaller MS4s in developing storm water programs.

In addition, in response to concerns that the rule should not require permit coverage for MS4s that do not significantly contribute to water quality impairments, today's rule provides options for two waivers for small MS4s. The rule allows permitting authorities to exempt from the requirement for a permit any MS4 serving a jurisdiction with a population less than 1,000, unless the State determines that the MS4 must implement storm water controls because it is significantly contributing to a water quality impairment. A second waiver option applies to MS4s serving a jurisdiction with a population less than 10,000. For those MS4s, the State must determine that discharges from the MS4 do not significantly contribute to a water quality impairment, or have the potential for such an impairment, in order to provide the exemption. The State must review this waiver on a periodic basis no less frequently than once every five years.

Throughout the development of today's rule, commenters questioned whether the Clean Water Act authorized the use of the NPDES permit program, pointing out that the text of CWA 402(p)(6) does not use the word ``permit.'' Based on the absence of the word ``permit'' and the express mention of State storm water management programs, the commenters asserted that Congress did not intend for Phase II sources to be regulated using NPDES permits.

EPA disagrees with the commenters' interpretation of section 402(p)(6). Section 402(p)(6) does not preclude use of permits as part of the ``comprehensive program'' to regulate designated sources. The language provides EPA with broad discretion in the establishment of the ``comprehensive program.'' Absence of the word ``permit'' (a term that the statute does not otherwise define) does not preclude use of a permit, which is a familiar and reasonably well understood regulatory implementation vehicle. First, section 402(p)(6) says that EPA must establish a comprehensive program that ``shall, at a minimum, establish priorities, establish requirements for State stormwater management programs, and establish expeditious deadlines.'' The ``at a minimum'' language suggests that the Agency may, and perhaps should, develop a comprehensive program that does more than merely attend to these minimum criteria. Use of the term ``at a minimum'' preserves for the Agency broad discretion to establish a comprehensive program that includes use of NPDES permits.

Further, in the final sentence of the section, Congress included additional language to affirm the Agency's discretion. The final sentence clarifies that the Phase II program ``may include performance standards, guidelines, guidance, and management practices and treatment requirements, as appropriate.'' Under existing CWA programs, performance standards, (effluent limitations) guidelines, management practices, and treatment requirements are typically implemented through NPDES or dredge and fill permits.

Although EPA believes that it had the discretion to not require permits, the Agency has determined that it is reasonable to interpret section 402(p)(6) to authorize permits. Moreover, for the reasons discussed above, the Agency believes that it is appropriate to use NPDES permits in implementing today's rule.

D. Federal Role

Today's final rule describes EPA's approach to expand the existing storm water program under CWA section 402(p)(6). As in all other Federal programs, the Federal government plays an integral role in complying with, developing, implementing, overseeing, and enforcing the program. This section describes EPA's role in the revised storm water program.

1. Develop Overall Framework of the Program

The storm water discharge control program under CWA section 402(p)(6) consists of the rule, tool box, and permits. EPA's primary role is to ensure timely development and implementation of all components. Today's rule is a refinement of the first step in developing the program. EPA is fully committed to continuing to work with involved stakeholders on developing the tool box and issuing permits. As noted in today's rule, EPA will assess the municipal storm water program based on (1) evaluations of data from the NPDES municipal storm water program, (2) research concerning water quality impacts on receiving waters from storm water, and (3) research on BMP effectiveness. (Section II.H, Municipal Role, provides a more detailed discussion of this provision.)

EPA is planning to standardize minimum requirements for construction and post-construction BMPs in a new rulemaking under Title III of the CWA. While larger construction sites are already subject to NPDES permits (and smaller sites will be subject to permits pursuant to today's rule), the permits generally do not contain specific requirements for BMP design or performance. The permits require the preparation of storm water pollution prevention plans, but actual BMP selection and design is at the discretion of permittees, in conformance with applicable State and local requirements. Where there are existing State and local requirements specific to BMPs, they vary widely, and many jurisdictions do not have such requirements.

In developing these regulations, EPA intends to evaluate the inclusion of design and maintenance criteria as minimum requirements for a variety of BMPs used for erosion and sediment control at construction sites, as well as for permanent BMPs used to manage post-construction storm water discharges. The Agency plans to consider the merits and performance of all appropriate management practices (both structural and non-structural) that can be used to reduce adverse water quality impacts. EPA does not intend to require the use of particular BMPs at specific sites, but plans to assist builders and developers in BMP selection by publishing data on the performance to be expected by various BMP types. EPA would like to build upon the successes of some of the effective State and local storm water programs currently in place around the country, and to establish nation-wide criteria to support builders and local jurisdictions in appropriate BMP selection.

2. Encourage Consideration of Smart Growth Approaches

In the proposal, EPA invited comment on possible approaches for providing

[[Page 68742]]

incentives for local decision making that would limit the adverse impacts of growth and development on water quality. EPA asked for comments on this ``smart growth'' approach.

EPA received comments on all sides of this issue. A number of commenters supported the idea of ``smart growth'' incentives but did not present concrete ideas. Several commenters suggested ``smart growth'' criteria. States that have adopted ``smart growth'' laws were worried that EPA's focus on urbanized areas for municipal requirements could encourage development outside of designated growth areas. Today's final rule clearly allows States to expand coverage of their municipal storm water program outside of urbanized areas. In addition, the flexibility of the six municipal minimum measures should avoid encouragement of development into rural rather than urban areas. For example, as part of the post-construction minimum measure, EPA recommends that municipalities consider policies and ordinances that encourage infill development in higher density urban areas, and areas with existing infrastructure, in order to meet the measure's intent.

EPA also received several comments expressing concern that incorporating ``smart growth'' incentives threatened the autonomy of local governments. One commenter was worried that ``incentives'' could become more onerous than the minimum measures. EPA is very aware of municipal concerns about possible federal interference with local land use planning. EPA is also cognizant of the difficulty surrounding incentives for ``smart growth'' activities due to these concerns. However, the Agency believes it has addressed these concerns by proposing a flexible approach and will continue to support the concept of ``smart growth'' by encouraging policies that limit the adverse impacts of growth and development on water quality.

3. Provide Financial Assistance

Although Congress has not established a fund to fully finance implementation of the proposed extension of the existing NPDES storm water program under CWA section 402(p)(6), numerous federal financing programs (administered by EPA and other federal agencies) can provide some financial assistance. The primary funding mechanism is the Clean Water State Revolving Fund (SRF) program, which provides sources of low-cost financing for a range of water quality infrastructure projects, including storm water. In addition to the SRF, federal financial assistance programs include the Water Quality Cooperative Agreements under CWA section 104(b)(3), Water Pollution Control Program grants to States under CWA section 106, and the Transportation Equity Act for the 21st Century (TEA-21) among others. In addition, Section 319 funds may be used to fund any urban storm water activities that are not specifically required by a draft or final NPDES permit. EPA will develop a list of potential funding sources as part of the tool box implementation effort. EPA anticipates that some of these programs will provide funds to help develop and, in limited circumstances, implement the CWA section 402(p)(6) storm water discharge control program.

EPA received numerous comments that requested additional funding. Congress provided one substantial new source of potential funding for transportation related storm water projects--TEA-21. The Department of Transportation has included a number of water-related provisions in its TEA-21 planning. These include Transportation Enhancements, Environmental Restoration and Pollution Abatement, and Environmental Streamlining. More information on TEA-21 is available at the following internet sites: www.fhwa.dot.gov/tea21/outreach.htm and www.tea21.org.

4. Implement the Program in Jurisdictions Not Authorized To Administer the NPDES Program

Because today's final rule uses the NPDES framework, EPA will be the NPDES permitting authority in several States, Tribal jurisdictions, and Territories. As such, EPA will have the same responsibilities as any other NPDES permitting authority--issuing permits, designating additional sources, and taking appropriate enforcement actions--and will seek to tailor the storm water discharge control program to the specific needs in that State, Tribal jurisdiction, or Territory. EPA also plans to provide support and oversight, including outreach, training, and technical assistance to the regulated communities. Section II.G. of today's preamble provides a separate discussion related to the NPDES permitting authority's responsibilities for today's final rule.

5. Oversee State and Tribal Programs

Under the NPDES program, EPA plays an oversight role for NPDES-approved States and Tribes. In this role, EPA and the State or Tribe work together to implement, enforce, and improve the NPDES program. Part of this oversight role includes working with States and Tribes to modify their programs where programmatic or implementation concerns impede program effectiveness. This role will be vitally important when States and Tribes make adjustments to develop, implement, and enforce today's [illegible] of the existing NPDES [illegible] control program. In addition, States maintain a continuing planning process (CPP) under CWA section 303(e), which EPA periodically reviews to assess the program's achievements.

In its oversight role, EPA takes action to address States and Tribes who have obtained NPDES authorization but are not fulfilling their obligations under the NPDES program. If an NPDES-authorized State or Tribe fails to implement an adequate NPDES storm water program, for example, EPA typically enters into extensive discussions to resolve outstanding issues. EPA has the authority to withdraw the entire NPDES program when resolution cannot be reached. Partial program withdrawal is not provided for under the CWA except for partial approvals.

EPA is also working with the States and Tribes to improve nonpoint source management programs and assessments to incorporate key program elements. Key nonpoint source program elements include setting short and long term goals and objectives; establishing public and private partnerships; using a balanced approach incorporating Statewide and watershed-wide abatement of existing impairments; preventing future impairments; developing processes to address both impaired and threatened waters; reviewing and upgrading all program components, including program revisions on a 5-year cycle; addressing federal land management and activities inconsistent with State programs; and managing State nonpoint source management programs effectively.

In particular, EPA works with the States and Tribes to strengthen their nonpoint source pollution programs to address all significant nonpoint sources, including agricultural sources, through the CWA section 319 program. EPA is working with other government agencies, as well as with community groups, to effect voluntary changes regarding watershed protection and reduced nonpoint source pollution.

In addition, EPA and NOAA have published programmatic and technical guidance to address coastal nonpoint source pollution. Under Section 6217 of the CZARA, States are developing and implementing coastal nonpoint pollution control programs approved by EPA and NOAA.

[[Page 68743]]

6. Comply With Applicable Requirements as a Discharger

Today's final rule covers federally operated facilities in a variety of ways. These facilities are generally areas where people reside, such as a federal prison, hospital, or military base. It also includes federal parkways and road systems with separate storm sewer systems. Today's rule requires federal MS4s to comply with the same application deadlines that apply to regulated small MS4s generally. EPA believes that all federal MS4s serve populations of less than 100,000.

EPA received several comments that asked if individual buildings like post offices are considered to be small MS4s and thereby regulated in today's rule if they are in an urbanized area. Most of these buildings have at most a parking lot with runoff or a storm sewer that connects with a municipality's MS4. EPA does not intend that individual federal buildings be considered to be small MS4s. This is discussed in section II.H.2.b. of today's preamble.

Federal facilities can also be included under requirements addressing storm water discharges associated with small construction activities. In any case, discharges from these facilities will need to comply with all applicable NPDES requirements and any additional water quality-related requirements imposed by a State, Tribal, or local government. Failure to comply can result in enforcement actions. Federal facilities can act as models for municipal and private sector facilities and implement or test state-of-the-art management practices and control measures

E. State Role

Today's final rule sets forth an NPDES approach for implementing the extension of the existing storm water discharge control program under CWA section 402(p)(6). State assumption of the NPDES program is voluntary, consistent with the principles of federalism. Because most States are approved to implement the NPDES program, they will tailor their storm water discharge control programs to address their water quality needs and objectives. While today's rule establishes the basic framework for the section 402(p)(6) program, States as well as Tribes (see discussion in section II.F) have an important role in fine-tuning the program to address the water quality issues within their jurisdictions. The basic framework allows for adjustments based on factors that vary geographically, including climate patterns and terrain.

Where States do not have NPDES authority, they are not required to implement the storm water discharge control program, but they may still participate in water quality protection through participation in the CWA section 401 certification process (for any permits) and through development of water quality standards and TMDLs.

1. Develop the Program

In expanding the existing NPDES program for storm water discharges, States must evaluate whether revisions to their NPDES programs are necessary. If so, modifications must be made in accordance with Sec. 123.62. Under Sec. 123.62, States must revise their NPDES programs within 1 year, or within 2 years if statutory changes are necessary.

Some States and departments of transportation (DOTs) commented that this timeframe is too short, anticipating that the State legislative process and the modification of regulations combined would take beyond 2 years. The deadline language in Sec. 123.62 is not new language for the storm water discharge control program; it applies to all NPDES programs. EPA believes the vast majority of States will meet the deadline and will work with States in those cases where there may be difficulty meeting this deadline due to the timing of legislative sessions and the regulatory development process.

An authorized State NPDES program must meet the requirements of CWA section 402(b) and conform to the guidelines issued under CWA section 304(i)(2). Today's final rule under Sec. 123.25 adds specific cross references to the storm water discharge control program components to ensure that States adequately address these requirements.

2. Comply With Applicable Requirements as a Discharger

Today's final rule covers State operated separate storm sewer systems in a variety of ways. These systems generally drain areas where people reside, such as a prison, hospital, or other populated facility. These systems are included under the definition of a regulated small MS4, which specifically identifies systems operated by State departments of transportation. Alternatively, storm water discharges from State activities may be regulated under the section addressing storm water discharges associated with small construction activities.

In any case, discharges from these facilities must comply with all applicable NPDES requirements. Failure to comply can result in enforcement actions. State facilities can act as models for municipal and private sector facilities and implement or test state-of-the-art management practices and control measures.

3. Communicate With EPA

Under approved NPDES programs, States have an ongoing obligation to share information with EPA. This dialogue is particularly important in the CWA section 402(p)(6) storm water program where these governments continue to develop a great deal of the guidance and outreach related to water quality.

F. Tribal Role

The proposal to today's final rule provides background information on EPA's 1984 Indian Policy and the criteria for treatment of an Indian Tribe in the same manner as a State. Today's final rule extends the existing NPDES program for storm water discharges to two types of dischargers located in Indian country. First, the final rule designates storm water discharges from any regulated small MS4, including Tribal systems. Second, the final rule regulates discharges associated with construction activity disturbing between one and five acres of land, including sites located in Indian country. Operators in each of these categories of regulated activity must apply for coverage under an NPDES permit by 3 years and 90 days from the date of publication of today's final rule. Under existing regulations, however, EPA or an authorized NPDES Tribe may require a specified storm water discharger to apply for NPDES permit coverage before this deadline based on a determination that the discharge is contributing to a violation of a water quality standard (including designated uses) or is a significant contributor of pollutants.

Under today's rule, a Tribal governmental entity may regulate storm water discharges on its reservation in two ways--as either an NPDES-authorized Tribe or as a regulated MS4. If a Tribe is authorized to operate the NPDES program, the Tribe must implement today's final rule for the NPDES program for storm water for covered dischargers located within the EPA recognized boundaries. Otherwise, EPA is generally the permitting/program authority within Indian country. Discussions about the State Role in the preceding section also apply to NPDES authorized Tribes. For additional information on the role and responsibilities of the permitting authority in the NPDES storm water program, see Sec. 123.35 (and Section II.G. of today's preamble) and Sec. 123.25(a).

[[Page 68744]]

Under today's final rule, if the Indian reservation is located entirely or partially within an ``urbanized area,'' as defined in Sec. 122.32(a)(1), the Tribe must obtain an NPDES permit if it operates a small MS4 within the urbanized area portion. Tribal MS4s located outside an urbanized area are not automatically covered, but may be designated by EPA pursuant to Sec. 122.32(a)(2) of today's rule or may request designation as a regulated small MS4 from EPA. A Tribe that is a regulated MS4 for NPDES program purposes is required to implement the six minimum control measures to the extent allowable under Federal law.

The Tribal representative on the Storm Water Phase II FACA Subcommittee asked EPA to provide a list of the Tribes located in urbanized areas that would fall within the NPDES storm water program under today's final rule. In December 1996, EPA developed a list of federally recognized American Indian Areas located wholly or partially in Bureau of the Census-designated urbanized areas (see Appendix 1).

Appendix 1 not only provides a listing of reservations and individual Tribes, but also the name of the particular urbanized area in which the reservation is located and an indication of whether the urbanized area contains a medium or large MS4 that is already covered by the existing Phase I regulations.

Some of the Tribes listed in Appendix 1 are only partially located in an urbanized area. If the Tribe's MS4 serves less than 1,000 people within an urbanized area, the permitting authority may waive the Tribe's MS4 storm water requirements if it meets the conditions of Sec. 122.32(c). EPA does not have information on the Tribal populations within the urbanized area, so it can not identify the Tribes that are eligible for a waiver. Therefore, a Tribe that believes it qualifies for a waiver should contact its permitting authority.

G. NPDES Permitting Authority's Role for the NPDES Storm Water Small MS4 Program

As noted previously, the NPDES permitting authority can be EPA or an authorized State or an authorized Tribe. The following discussion describes the role of the NPDES permitting authority under today's final rule.

1. Comply With Implementation Requirements

NPDES permitting authorities must perform certain duties to implement the NPDES storm water municipal program. Section 123.35(a) of today's final rule emphasizes that permitting authorities have existing obligations under the NPDES program. Section 123.35 focuses on specific issues related to the role of the NPDES authority to support administration and implementation of the municipal storm water program under CWA section 402(p)(6).

2. Designate Sources

Section 123.35(b) of today's final rule addresses the requirements for the NPDES permitting authority to designate sources of storm water discharges to be regulated under Secs. 122.32 through 122.36. NPDES permitting authorities must develop a process, as well as criteria, to designate small MS4s. They must also have the authority to designate a small MS4 if and when circumstances that support a waiver under Sec. 122.32(c) change. EPA may make designations if an NPDES-approved State or Tribe fails to do so.

NPDES permitting authorities must examine geographic jurisdictions that they believe should be included in the storm water discharge control program but are not located in an ``urbanized area''. Small MS4s in these areas are not designated automatically. Discharges from such areas should be brought into the program if found to have actual or potential exceedances of water quality standards, including impairment of designated uses, or other adverse impacts on water quality, as determined by local conditions or watershed and TMDL assessments. EPA's aim is to address discharges to impaired waters and to protect waters with the potential for problems. EPA encourages NPDES permitting authorities, local governments, and the interested public to work together in the context of a watershed plan to address water quality issues, including those associated with municipal storm water runoff.

EPA received comments stating that the process of developing criteria and applying it to all MS4s outside an urbanized area serving a population of 10,000 or greater and with a density of 1,000 people per square mile is too time-consuming and resource-intensive. These commenters believe that the permitting authority should decide which MS4s must be brought into the storm water discharge control program and that population and density should not be an overriding criteria. One suggested way of doing so was to only designate MS4s with demonstrated contributions to the impairment of water quality uses as shown by a TMDL. EPA disagrees with this suggestion. The TMDL process is time-consuming. MS4s outside of urbanized areas may cause water quality problems long before a TMDL is completed.

EPA believes that permitting authorities should consider the potential water quality impacts of storm water from all jurisdictions with a population of 10,000 or greater and a density of 1,000 people per square mile. EPA is using data summarized in the NURP study and in the CWA section 305(b) reports to support this approach for targeted designation outside of urbanized areas. EPA is not mandating which criteria are to be used, but has provided examples of criteria that may be useful in evaluating potential water quality impacts. EPA believes that the flexibility provided in this section of today's final rule allows the permitting authority to develop criteria and a designation process that is easy to use and protects water quality. Therefore, the provisions of Sec. 123.35(b) remain as proposed.

a. Develop Designation Criteria

Under Sec. 123.35(b), the NPDES permitting authority must establish designation criteria to evaluate whether a storm water discharge results in or has the potential to result in exceedances of water quality standards, including impairment of designated uses, or other significant water quality impacts, including adverse habitat and biological impacts.

EPA recommends that NPDES permitting authorities consider, in a balanced manner, certain locally-focused criteria for designating any MS4 located outside of an urbanized area on the basis of significant water quality impacts. EPA recommends consideration of criteria such as discharge to sensitive waters, high growth or growth potential, high population density, contiguity to an urbanized area, significant contribution of pollutants to waters of the United States, and ineffective control of water quality concerns by other programs. These suggested designation criteria are intended to help encourage the permitting authority to use an objective method for identifying and designating, on a local basis, sources that adversely impact water quality. More information about these criteria and the reasons why they are suggested by EPA is included in the January 9, 1998, proposal (63 FR 1561) for today's final rule.

The suggested criteria are meant to be taken in the aggregate, with a great deal of flexibility as to how each should be weighed in order to best account for watershed and other local conditions and to allow for a more tailored case-by-case analysis. The application of criteria is meant to be geographically specific. Furthermore, each criterion does not have to be met in order for a small MS4

[[Page 68745]]

to qualify for designation, nor should an MS4 necessarily be designated on the basis of one or two criteria alone.

EPA believes that the application of the recommended designation criteria provides an objective indicator of real and potential water quality impacts from urban runoff on both the local and watershed levels. EPA encourages the application of the recommended criteria in a watershed context, thereby allowing for the evaluation of the water quality impacts of the portions of a watershed outside of an urbanized area. For example, situations exist where the urbanized area represents a small portion of a degraded watershed, and the adjacent nonurbanized areas of the watershed have significant cumulative effects on the quality of the receiving waters.

EPA received numerous suggestions of additional criteria that should be added and reasons why some of the criteria in the proposal to today's final rule were not appropriate. EPA developed its suggested designation criteria based on findings of the NURP study and other studies that indicate pollutants of concern, including total suspended solids, chemical oxygen demand, and temperature. These criteria were the subject of considerable discussion by the Storm Water Phase II FACA Subcommittee. EPA developed them in response to recommendations from the subcommittee during development of the proposed rule. The listed criteria are only suggestions. Permitting authorities are required to develop their own criteria. EPA has not found any reason to change its suggested list of criteria and the suggestions remain as proposed.

b. Apply Designation Criteria

After customizing the designation criteria for local conditions, the permitting authority must apply such criteria, at a minimum, to any MS4 located outside of an urbanized area serving a jurisdiction with a population of at least 10,000 and a population density of 1,000 people per square mile or greater (see Sec. 123.35(b)(2)). If the NPDES permitting authority determines that an MS4 meets the criteria, the permitting authority must designate it as a regulated small MS4. This designation must occur within 3 years of publication of today's final rule. Alternatively, the NPDES authority can designate within 5 years from the date of final regulation if the designation criteria are applied on a watershed basis where a comprehensive watershed plan exists (a comprehensive watershed plan is one that includes the equivalents of TMDLs) (see Sec. 123.35(b)(3)). The extended 5 year deadline is intended to provide incentives for watershed-based designations. If an NPDES-authorized State or Tribe does not develop and apply designation criteria within this timeframe, then EPA has the opportunity to do so in lieu of the authorized State or Tribe.

NPDES permitting authorities can designate any small MS4, including one below 10,000 in population and 1,000 in density. EPA established the 10,000/1,000 threshold based on the likelihood of adverse water quality impacts at these population and density levels. In addition, the 1,000 persons per square mile threshold is consistent with both the Bureau of the Census definition of an ``urbanized area'' (see Section II.H.2. below) and stakeholder discussions concerning the definition of a regulated small MS4.

One commenter requested that EPA develop interim deadlines for development of designation criteria. EPA believes that the designation deadline identified in today's final rule at Sec. 123.35(b)(3) provides States and Tribes with a flexibility that allows them to develop and apply the criteria locally in a timely fashion, while at the same time establishing an expeditious deadline.

c. Designate Physically Interconnected Small MS4s

In addition to applying criteria on a local basis for potential designation, the NPDES permitting authority must designate any MS4 that contributes substantially to the pollutant loadings of a physically interconnected municipal separate storm sewer that is regulated by the NPDES program for storm water discharges (see Sec. 123.35(b)(4)). To be ``physically interconnected,'' the MS4 of one entity, including roads with drainage systems and municipal streets, is physically connected directly to the municipal separate storm sewer of another entity. This provision applies to all MS4s located outside of an urbanized area. EPA added this section in recognition of the concerns of local government stakeholders that a local government should not have to shoulder total responsibility for a storm water program when storm water discharges from another MS4 are also contributing pollutants or adversely affecting water quality. This provision also helps to provide some consistency among MS4 programs and to facilitate watershed planning in the implementation of the NPDES storm water program. EPA recommended physical interconnectedness in the existing NPDES storm water regulations as a factor for consideration in the designation of additional sources.

Today's final rule does not include interim deadlines for identifying physically interconnected MS4s. However, consistent with the deadlines identified in Sec. 123.35(b)(3) of today's final rule, EPA encourages the permitting authority to make these determinations within 3 years from the date of publication of the final rule or within 5 years if the permitting authority is implementing a comprehensive watershed plan. Alternatively, the affected jurisdiction could use the petition process under 40 CFR 122.26(f) in seeking to have the permitting authority designate the contributing jurisdiction.

Several commenters expressed concerns about who could be designated under this provision (Sec. 123.35(b)(4)). One commenter requested that the word ``substantially'' be deleted from the rule because they believe any MS4 that contributes at all to a physically interconnected municipal separate storm sewer should be regulated. EPA believes that the word ``substantially'' provides necessary flexibility to the permitting authorities. The permitting authority can decide if an MS4 is contributing discharges to another municipal separate storm sewer in a manner that requires regulation. If the operator of a regulated municipal separate storm sewer believes that some of its pollutant loadings are coming from an unregulated MS4, it can petition the permitting authority to designate the unregulated MS4 for regulation.

d. Respond to Public Petitions for Designation

Today's final rule reiterates the existing opportunity for the public to petition the permitting authority for designation of a point source to be regulated to protect water quality. The petition opportunity also appears in existing NPDES regulations at 40 CFR 122.26(f). Any person may petition the permitting authority to require an NPDES permit for a discharge composed entirely of storm water that contributes to a violation of a water quality standard or is a significant contributor of pollutants to the waters of the United States (see Sec. 123.32(b)). The NPDES permitting authority must make a final determination on any petition within 180 days after receiving the petition (see Sec. 123.35(c)). EPA believes that a 180 day limit balances the public's need for a timely final determination with the NPDES permitting authority's need to prioritize its workload. If an NPDES-approved State or Tribe fails to act

[[Page 68746]]

within the 180-day timeframe, EPA may make a determination on the petition. EPA believes that public involvement is an important component of the NPDES program for storm water and feels that this provision encourages public participation. Section II.K, Public Involvement/Public Role, further discusses this topic.

3. Provide Waivers

Today's rule provides two opportunities for the NPDES permitting authority to exempt certain small MS4s from the need for a permit based on water quality considerations. See Secs. 122.32(d) and (e). The two waiver opportunities have different size thresholds and take different approaches to considering the water quality impacts of discharges from the MS4.

In the proposal, EPA requested comment on the option of waiving coverage for all MS4s with less than 1,000 people unless the permitting authority determined that the small MS4 should be regulated based on significant adverse water quality impacts. A number of commenters supported this option. They expressed concern that compliance with the rule requirements and certification of one of the waiver provisions were both costly for very small communities. They stated that the permitting authority should identify a water quality problem before requiring compliance. Today's rule essentially adopts this alternative approach for MS4s serving a population under 1,000.

The final rule has expanded the waiver provision that EPA proposed for small MS4s with a population less than 1,000. The proposed rule would have required a small MS4 operator to certify that storm water controls are not needed based on either wasteload allocations that are part of TMDLs that address the pollutants of concern, or a comprehensive watershed plan implemented for the waterbody that includes the equivalents of TMDLs and addresses the pollutant(s) of concern. Commenters noted that the proposed waivers would be unattainable if a TMDL or equivalent analysis was required for every pollutant that could possibly be present in any amount in discharges from an MS4 regardless of whether the pollutant is causing water quality impairment. Commenters asked that EPA identify what constitutes the ``pollutant(s) of concern'' for which a TMDL or its equivalent must be developed. For example, Sec. 122.30(c) indicates that the MS4 program is intended to control ``sediment, suspended solids, nutrients, heavy metals, pathogens, toxins, oxygen-demanding substances, and floatables.'' Commenters asked whether TMDLs or equivalent analyses have to address all of these.

EPA has revised the proposed waiver in response to these concerns. Under today's rule, NPDES permitting authorities may waive the requirements of today's rule for any small MS4 with a population less than 1,000 that does not contribute substantially to the pollutant loadings of a physically interconnected MS4, unless the small MS4 discharges pollutants that have been identified as a cause of impairment of the waters to which the small MS4 discharges. If the small MS4 does discharge pollutants that have been identified as impairing the water body into which the small MS4 discharges, the NPDES permitting authority may grant a waiver only if it determines that storm water controls are not needed based on an EPA approved or established TMDL that addresses the pollutant(s) of concern.

Unlike the proposed rule, Sec. 122.32(d) does not allow the waiver for MS4s serving a population under 1,000 to be based on ``the equivalent of a TMDL.'' Because Sec. 122.32(d) requires a pollutant specific analysis only for a pollutant that has been identified as a cause of impairment, a TMDL is required for such pollutant before the waiver may be granted. Once a pollutant has been identified as the cause of impairment of a water body, the State should develop a TMDL for that pollutant for that water body. Thus, Sec. 122.32(d) takes a different approach than that taken for the waiver in Sec. 122.32(e) for MS4s serving a population under 10,000, which can be based upon an analysis that is ``the equivalent of a TMDL.'' This is because Sec. 122.32(d) requires an analysis to support the waiver for MS4s under 1,000 only if a waterbody to which the MS4 discharges has been identified as impaired. The Sec. 122.32(e) waiver, on the other hand, would be available for larger MS4s but only after the State affirmatively establishes lack of impairment based upon a comprehensive analysis of smaller urban waters that might not otherwise be evaluated for the purposes of CWA section 303. Since Sec. 122.32(e) requires the analysis of waters that have not been identified as impaired, an actual TMDL is not required and an analysis that is the equivalent of a TMDL can suffice to support the waiver.

Where a State is the NPDES permitting authority, the permitting authority is responsible for the development of the TMDLs as well as the assessment of the extent to which a small MS4's discharge contributes pollutants to a neighboring regulated system. In States where EPA is the permitting authority, EPA will use a State's TMDLs to determine whether storm water controls are required for the small MS4s.

The proposed rule would have required the operator of the small MS4 serving a population under 1,000 to certify that its discharge was covered under a TMDL that indicated that discharges from its particular system were not having an adverse impact on water quality (i.e., it was either not assigned wasteload allocations under TMDLs or its discharge is within an assigned allocation). Many commenters expressed concerns that MS4 operators serving less than 1,000 persons may lack the technical capacity to certify that their discharges are not contributing to adverse water quality impacts. These commenters thought that the permitting authority should make such a certification. Today's rule provides flexibility in how the waiver is administered. Permitting authorities are ultimately responsible for granting the waiver, but are free to determine whether or not to require small MS4 operators that are seeking waivers to submit information or a written certification.

Under Sec. 122.32(e) a State may grant a waiver to an MS4 serving a population between 1,000 and 10,000 only if the State has made a comprehensive effort to ensure that the MS4 will not cause or contribute to water quality impairment. To grant a Sec. 122.32(e) waiver, the NPDES permitting authority must evaluate all waters of the U.S. that receive a discharge from the MS4 and determine that storm water controls are not needed. The permitting authority's evaluation must be based on wasteload allocations that are part of an EPA approved or established TMDL or, if a TMDL has not been developed or approved, an equivalent analysis that determines sources and allocations for the pollutant(s) of concern. The pollutants of concern that the permitting authority must evaluate include biochemical oxygen demand (BOD), sediment or a parameter that addresses sediment (such as total suspended solids, turbidity or siltation), pathogens, oil and grease, and any other pollutant that has been identified as a cause of impairment of any water body that will receive a discharge from the MS4. Finally, the permitting authority must have determined that future discharges from the MS4 do not have the potential to result in exceedances of water quality standards, including impairment of designated uses, or other significant

[[Page 68747]]

water quality impacts, including habitat and biological impacts.

Although EPA did not propose this specific approach, the Agency did request comment on whether to increase the proposed 1,000 population threshold for a waiver. The Sec. 122.32(e) waiver was developed in response to comments, including States' concerns that they needed greater flexibility to focus their efforts on MS4s that were causing water quality impairment. Several commenters thought that the threshold should be increased from 1,000 to 5,000 or 10,000. Others suggested additional ways of qualifying for a waiver for MS4s that discharge to waters that are not covered by a TMDL or watershed plan. EPA carefully considered all the options for expanding the waiver provisions and has decided to expand the waiver only in the very narrow circumstances described above where a comprehensive analysis has been undertaken to demonstrate that the MS4 is not causing water quality impairment.

The NPDES permitting authority can, at any time, mandate compliance with program requirements from a previously waived small MS4 if circumstances change. For example, a waiver can be withdrawn in circumstances where the permitting authority later determines that a waived small MS4's storm water discharge to a small stream will cause adverse impacts to water quality or significantly interfere with attainment of water quality standards. A ``change in circumstances'' could involve receipt of new information. Changed circumstances can also allow a regulated small MS4 operator to request a waiver at any time.

Some commenters expressed concerns about allowing any small MS4 waivers. One commenter stated that storm water pollution prevention plans are necessary to control storm water pollution and should be required from all regulated small MS4s. For the reasons stated in the Background section above, EPA agrees that the discharges from most MS4s in urbanized areas should be addressed by a storm water management program outlined in today's rule. For MS4s serving very small areas, however, the TMDL development process provides an opportunity to determine whether an MS4 serving a population less than 1,000 is having a negative impact on any receiving water that is impaired by a pollutant that the MS4 discharges. MS4s serving populations up to 10,000 may receive a waiver only if a comprehensive analysis of its impact on receiving water has been performed.

Other commenters said that waivers should not be allowed for small MS4s that discharge into another regulated MS4. These commenters stated that the word ``substantially'' should be removed from Sec. 122.32(d)(i) so that a waiver would not be allowed for any system ``contributing to the storm water pollutant loadings of a physically interconnected regulated MS4.'' As previously mentioned under the designation discussion of section II.G.2.c, EPA believes that the word ``substantially'' provides needed flexibility to the permitting authorities. It is important to note that this is only one aspect that the permitting authority must consider when deciding on the appropriateness of a waiver.

4. Issue Permits

NPDES permitting authorities have a number of responsibilities regarding the permit process. Sections 123.35(d) through (g) ensure a certain level of consistency for permits, yet provide numerous opportunities for flexibility. NPDES permitting authorities must issue NPDES permits to cover municipal sources to be regulated under Sec. 122.32, unless waived under Sec. 122.32(c). EPA encourages permitting authorities to use general permits as the vehicle for permitting and regulating small MS4s. The Agency notes, however, that some operators may wish to take advantage of the option to join as a co-permittee with an MS4 regulated under the existing NPDES storm water program.

Today's final rule includes a provision, Sec. 123.35(f), that requires NPDES permitting authorities to either include the requirements in Sec. 122.34 for NPDES permits issued for regulated small MS4s or to develop permit limits based on a permit application submitted by a small MS4. See Section II.H.3.a, Minimum Control Measures, for more details on the actual Sec. 122.34 requirements. See Section II.H.3.c for alternative and joint permitting options.

In an attempt to avoid duplication of effort, Sec. 122.34(c) allows NPDES permitting authorities to include permit conditions that direct an MS4 to meet the requirements of a qualifying local, Tribal, or State municipal storm water management program. For a local, Tribal, or State program to ``qualify,'' it must impose, at a minimum, the relevant requirements of Sec. 122.34(b). A regulated small MS4 must still follow the procedural requirements for an NPDES permit (i.e., submit an application, either an individual application or an NOI under a general permit) but will instead follow the substantive pollutant control requirements of the qualifying local, Tribal, or State program.

Under Sec. 122.35(b), NPDES permitting authorities may also recognize existing responsibilities among governmental entities for the minimum control measures in an NPDES small MS4 storm water permit. For example, the permit might acknowledge the existence of a State administered program that addresses construction site runoff and require that the municipalities only develop substantive controls for the remaining minimum control measures. By acknowledging existing programs, this provision is meant to reduce the duplication of efforts and to increase the flexibility of the NPDES storm water program.

Section 123.35(e) of today's final rule requires permitting authorities to specify a time period of up to 5 years from the issuance date of an NPDES permit for regulated small MS4 operators to fully develop and implement their storm water programs. As discussed more fully below, permitting authorities should be providing extensive support to the local governments to assist them in developing and implementing their programs.

In the proposed rule, EPA stated that the permitting authority would develop the menu of BMPs and if they failed to do so, EPA would develop the menu. Commenters felt that EPA should develop a menu of BMPs, rather than just providing guidance. In the settlement agreement for seeking an extension to the deadline for issuing today's rule, EPA committed to developing a menu of BMPs by October 27, 2000. Permitting authorities can adopt EPA's menu or develop their own. The menu itself is not intended to replace more comprehensive BMP guidance materials. As part of the tool box efforts, EPA will provide separate guidance documents that discuss the results from EPA-sponsored nationwide studies on the design, operation and maintenance of BMPs. Additionally, EPA expects that the new rulemaking on construction BMPs may provide more specific design, operation and maintenance criteria.

5. Support and Oversee the Local Programs

NPDES permitting authorities are responsible for supporting and overseeing the local municipal programs. Section 123.35(h) of today's final rule highlights issues associated with these responsibilities.

To the extent possible, NPDES permitting authorities should provide financial assistance to MS4s, which

[[Page 68748]]

often have limited resources, for the development and implementation of local programs. EPA recognizes that funding for programs at the State and Tribal levels may also be limited, but strongly encourages States and Tribes to provide whatever assistance is possible. In lieu of actual dollars, NPDES permitting authorities can provide cost-cutting assistance in a number of ways. For example, NPDES permitting authorities can develop outreach materials for MS4s to distribute or the NPDES permitting authority can actually distribute the materials. Another option is to implement an erosion and sediment control program across an entire State (or Tribal land), thus alleviating the need for the MS4 to implement its own program. The NPDES permitting authority must balance the need for site-specific controls, which are best handled by a local MS4, with its ability to offer financial assistance. EPA, States, Tribes, and MS4s should work as a team in making these kinds of decisions.

NPDES permitting authorities are responsible for overseeing the local programs. Permitting authorities should work with the regulated community and other stakeholders to assist in local program development and implementation. This might include sharing information, analyzing reports, and taking enforcement actions, as necessary. NPDES permitting authorities play a vital role in supporting local programs by providing technical and programmatic assistance, conducting research projects, and monitoring watersheds. The NPDES permitting authority can also assist the MS4 permittee in obtaining adequate legal authority at the local level in order to implement the local component of the CWA section 402(p)(6) program.

NPDES permitting authorities are encouraged to coordinate and utilize the data collected under several programs. States and Tribes address point and nonpoint source storm water discharges through a variety of programs. In developing programs to carry out CWA section 402(p)(6), EPA recommends that States and Tribes coordinate all of their water pollution evaluation and control programs, including the continuing planning process under CWA section 303(e), the existing NPDES program, the CZARA program, and nonpoint source pollution control programs.

In addition, NPDES permitting authorities are encouraged to provide a brief (e.g., two-page) reporting format to facilitate compilation and analysis of data from reports submitted under Sec. 122.34(g)(3). EPA intends to develop a model form for this purpose.

H. Municipal Role

1. Scope of Today's Rule

Today's final rule attempts to establish an equitable and comprehensive four-pronged approach for the designation of municipal sources. First, the approach defines for automatic coverage the municipal systems believed to be of highest threat to water quality. Second, the approach designates municipal systems that meet a set of objective criteria used to measure the potential for water quality impacts. Third, the approach designates on a case-by-case basis municipal systems that ``contribute substantially to the pollutant loadings of a physically-interconnected [regulated] MS4.'' Finally, the approach designates on a case-by-case basis, upon petition, municipal systems that ``contribute to a violation of a water quality standard or are a significant contributor of pollutants.''

Today's final rule automatically designates for regulation small MS4s located in urbanized areas, and requires that NPDES permitting authorities examine for potential designation, at a minimum, a particular subset of small MS4s located outside of urbanized areas. Today's rule also includes provisions that allow for waivers from the otherwise applicable requirements for the smallest MS4s that are not causing impairment of a receiving water body. Qualifications for the waivers vary depending on whether the MS4 serves a population under 1,000 or a population under 10,000. See Secs. 122.32(d) and (e). These waivers are discussed further in section II.G.3. Any small MS4 automatically designated by the final rule or designated by the permitting authority under today's final rule is defined as a ``regulated'' small MS4 unless it receives a waiver.

In today's final rule, all regulated small MS4s must establish a storm water discharge control program that meets the requirements of six minimum control measures. These minimum control measures are public education and outreach on storm water impacts, public involvement participation, illicit discharge detection and elimination, construction site storm water runoff control, post-construction storm water management in new development and redevelopment, and pollution prevention/good housekeeping for municipal operations.

Today's rule allows for a great deal of flexibility in how an operator of a regulated small MS4 is authorized to discharge under an NPDES permit, by providing various options for obtaining permit coverage and satisfying the required minimum control measures. For example, the NPDES permitting authority can incorporate by reference qualifying State, Tribal, or local programs in an NPDES general permit and can recognize existing responsibilities among different governmental entities for the implementation of minimum control measures. In addition, a regulated small MS4 can participate in the storm water management program of an adjoining regulated MS4 and can arrange to have another governmental entity implement a minimum control measure on their behalf.

2. Municipal Definitions

a. Municipal Separate Storm Sewer Systems (MS4s)

The CWA does not define the term ``municipal separate storm sewer.'' EPA defined municipal separate storm sewer in the existing storm water permit application regulations to mean, in part, a conveyance or system of conveyances (including roads with drainage systems and municipal streets) that is ``owned or operated by a State, city, town borough, county, parish, district, association, or other public body * * * designed or used for collecting or conveying storm water which is not a combined sewer and which is not part of a Publicly Owned Treatment Works as defined at 40 CFR 122.2'' (see Sec. 122.26(b)(8)(i)). Section 122.26 contains definitions of medium and large municipal separate storm sewer systems but no definition of a municipal separate storm sewer system, even though the term MS4 is commonly used. In today's rule, EPA is adding a definition of municipal separate storm sewer system and small municipal separate storm sewer system along with the abbreviations MS4 and small MS4.

The existing municipal permit application regulations define ``medium'' and ``large'' MS4s as those located in an incorporated place or county with a population of at least 100,000 (medium) or 250,000 (large) as determined by the latest Decennial Census (see Secs. 122.26(b)(4) and 122.26(b)(7)). In today's final rule, these regulations have been revised to define all medium and large MS4s as those meeting the above population thresholds according to the 1990 Decennial Census.

Today's rule also corrects the titles and contents of Appendices F, G, H, & I to Part 122. EPA is adding those incorporated places and counties whose 1990 population caused them to be defined as a ``medium'' or ``large'' MS4. All of these MS4s have applied for

[[Page 68749]]

permit coverage so the effect of this change to the appendices is simply to make them more accurate. They will not need to be revised again because today's rule ``freezes'' the definition of ``medium'' and ``large'' MS4s at those that qualify based on the 1990 census.

EPA received several comments supporting and opposing the proposal to ``freeze'' the definitions based on the 1990 census. Commenters who disagreed with EPA's position cited the unfairness of municipalities that reach the medium or large threshold at a later date having fewer permitting requirements compared to those that were already at the population thresholds when the existing storm water regulations took effect. EPA recognizes this disparity but does not believe it is unfair, as explained in the proposed rule. The decision was based on the fact that the deadlines from the existing regulations have lapsed, and because the permitting authority can always require more from operators of MS4s serving ``newly over 100,000'' populations.

b. Small Municipal Separate Storm Sewer Systems

The proposal to today's final rule added ``the United States'' as a potential owner or operator of a municipal separate storm sewer. This addition was intended to address an omission from existing regulations and to clarify that federal facilities are, in fact, covered by the NPDES program for municipal storm water discharges when the federal facility is like other regulated MS4s. EPA received a comment that this change would cause federal facilities located in Phase 1 areas to be considered Phase 1 dischargers due to the definition of medium and large MS4s. All MS4s located in Phase 1 cities or counties are defined as Phase 1 medium or large MS4s. EPA believes that all federal facilities serve a population of under 100,000 and should be regulated as small MS4s. Therefore, in Sec. 122.26(a)(16) of today's final rule, EPA is adding federal facilities to the NPDES storm water discharge control program by changing the proposed definition of small municipal separate storm sewer system. Paragraph (i) of this section restates the definition of municipal separate storm sewer with the addition of ``the United States'' as a owner or operator of a small municipal separate storm sewer. Paragraph (ii) repeats the proposed language that states that a small MS4 is a municipal separate storm sewer that is not medium or large.

Most commenters agreed that federal facilities should be covered in the same way as other similar MS4s. However, EPA received several comments asking whether individual federal buildings such as post offices or urban offices of the U.S. Park Service must apply for coverage as regulated small MS4s. Most of these buildings have, at most, a parking lot with runoff or a storm sewer that connects with a municipality's MS4. In Sec. 122.26(a)(16)(iii), EPA clarifies that the definition of small MS4 does not include individual buildings. These buildings may have a municipal separate storm sewer but they do not have a ``system'' of conveyances. The minimum measures for small MS4s were written to apply to storm sewer ``systems'' providing storm water drainage service to human populations and not to individual buildings. This is true of municipal separate storm sewers from State buildings as well as from federal buildings.

There will likely be situations where the permitting authority must decide if a federal or State complex should be regulated as a small MS4. A federal complex of two or three buildings could be treated as a single building and not be required to apply for coverage. In these situations, permitting authorities will have to use their best judgment as to the nature of the complex and its storm water conveyance system. Permitting authorities should also consider whether the federal or State complex cooperates with its municipality's efforts to implement their storm water management program.

Along with the questions about individual buildings, EPA received many questions about how various provisions of the rule should be interpreted for federal and State facilities. EPA acknowledges that federal and State facilities are different from municipalities. EPA believes, however, that the minimum measures are flexible enough that they can be implemented by these facilities. As an example, DOD commenters asked about how to interpret the term ``public'' for military installations when implementing the public education measure. EPA agrees with the suggested interpretation of ``public'' for DOD facilities as ``the resident and employee population within the fence line of the facility.''

EPA also received many comments from State departments of transportation (DOTs) that suggested the ways in which they are different from municipalities and should therefore be regulated differently. Storm water discharges from State DOTs in Phase 1 areas should already be regulated under Phase I. The preamble to Phase 1 clearly states that ``all systems within a geographical area including highways and flood control districts will be covered.'' Many permitting authorities regulated State DOTs as co-permittees with the Phase 1 municipality in which the highway is located. State DOTs that are already regulated under Phase I are not required to comply with Phase II. State DOTs that are not already regulated have various options for meeting the requirements of today's rule. These options are discussed in Section II.H.3.c.iv below. Several DOTs commented that some of the minimum measures are outside the scope of their mission or that they do not have the legal authority required for implementation. EPA believes that the flexibility of the minimum measures allows them to be implemented by most MS4s, including DOTs. When a DOT does not have the necessary legal authority, EPA encourages the DOT to coordinate their storm water management efforts with the surrounding municipalities and other State agencies. Under today's rule, DOTs can use any of the options of Sec. 122.35 to share their storm water management responsibilities. DOTs may also want to work with their permitting authority to develop a State-wide DOT storm water permit.

There are many storm water discharges from State DOTs and other State MS4s located in Phase 1 areas that were not regulated under Phase 1. Today's rule adds many more State facilities as well as all federal facilities located in urbanized areas. All of these State and federal facilities that fit the definition of a small MS4 must be covered by a storm water management program. The individual permitting authorities must decide what type of permit is most applicable.

The existing NPDES storm water program already regulates storm water from federally or State-operated industrial sources. Federal or State facilities that are currently regulated due to their industrial discharges may already be implementing some of today's rule requirements.

EPA received comments that questioned the apparent inconsistency between regulating a federal facility such as a hospital and not regulating a similar private facility. Normally, this type of private facility is regulated by the MS4. EPA believes that federal facilities are subject to local water quality regulations, including storm water requirements, by virtue of the waiver of sovereign immunity in CWA section 313. However, there are special problems faced by MS4s in their efforts to regulate federal facilities that have not been encountered in regulating

[[Page 68750]]

similar private facilities. To ensure comprehensive coverage, today's rule merely clarifies the need for permit coverage for these federal facilities.

i. Combined Sewer Systems (CSS). The definition of small MS4s does not include combined sewer systems. A combined sewer system is a wastewater collection system that conveys sanitary wastewater and storm water through a single set of pipes to a publicly-owned treatment works (POTW) for treatment before discharging to a receiving waterbody. During wet weather events when the capacity of the combined sewer system is exceeded, the system is designed to discharge prior to the POTW treatment plant directly into a receiving waterbody. Such an overflow is a combined sewer overflow or CSO. Combined sewer systems are not subject to existing regulations for municipal storm water discharges, nor will they be subject to today's regulations. EPA addresses combined sewer systems and CSOs in the National Combined Sewer Overflow (CSO) Control Policy issued on April 19, 1994 (59 FR 18688). The CSO Control Policy contains provisions for developing appropriate, site-specific NPDES permit requirements for combined sewer systems. CSO discharges are subject to limitations based on the best available technology economically achievable for toxic pollutants and based on the best conventional pollutant control technology for conventional pollutants. MS4s are subject to a different technology standard for all pollutants, specifically to reduce pollutants to the maximum extent practicable.

Some municipalities are served by both separate storm sewer systems and combined sewer systems. If such a municipality is located within an urbanized area, only the separate storm sewer systems within that municipality is included in the NPDES storm water program and subject to today's final rule. If the municipality is not located in an urbanized area, then the NPDES permitting authority has discretion as to whether the discharges from the separate storm sewer system is subject to today's final rule. The NPDES permitting authority will use the same process to designate discharges from portions of an MS4 for permit coverage where the municipality is also served by a combined sewer system.

EPA recognizes that municipalities that have both combined and separate storm sewer systems may wish to find ways to develop a unified program to meet all wet weather water pollution control requirements more efficiently. In the proposal to today's final rule, EPA sought comment on ways to achieve such a unified program. Many municipalities that are served by CSSs and MS4s commented that it is inequitable to force them to comply with Phase II at this time because implementation of the CSO Control Policy through their NPDES permits already imposes a significant financial burden. They requested an extension of the implementation time frame. They did not provide ideas on how to unify the two programs. EPA encourages permitting authorities to work with these municipalities as they develop and begin implementation of their CSO and storm water management programs. If both sets of requirements are carefully coordinated early, a cost-effective wet weather program can be developed that will address both CSO and storm water requirements.

ii. Owners/Operators. Several commenters mentioned the difference between the existing storm water application requirement for municipal operators and the proposed municipal requirement for owners or operators to apply. They felt that this inconsistency is confusing. The preamble to the existing regulations makes numerous references to owner/operator so there was no intent to make a clear distinction between Phase I and Phase II. Section 122.21(b) states that when the owner and operator are different, the operator must obtain the permit. MS4s often have several operators. The owner may be responsible for one part of the system and a regional authority may be responsible for other aspects. EPA proposed the ``owner or operator'' language to convey this dual responsibility. However, when the owner is responsible for some part of a storm water management plan, it is also an operator.

EPA has revised the regulation language to clarify that ``an operator'' must apply for a permit. When responsibilities for the MS4 are shared, all operators must apply.

c. Regulated Small MS4s

In today's final rule, all small MS4s located in an urbanized area are automatically designated as ``regulated'' small MS4s provided that they were not previously designated into the existing storm water program. Unlike medium and large MS4s under the existing storm water regulations, not all small MS4s are designated under today's final rule. Therefore, today's rule distinguishes between ``small'' MS4s and ``regulated small'' MS4s.

EPA's definition of ``regulated small MS4s'' in the proposal to today's rule included mention of incorporated places and counties. Along with the definition, EPA included Appendices 6 and 7 to assist in the identification of areas that would probably require coverage as ``automatically designated'' (Appendix 6) or ``potentially designated'' (Appendix 7). The definition and the appendices raised many questions about exactly who was required to comply with the proposed requirements. Commenters raised issues about the definition of ``incorporated place'' and the status of towns, townships, and other places that are not considered incorporated by the Census Bureau. They also asked about special districts, regional authorities, MS4s already regulated, and other questions in order to clarify the rule's coverage.

EPA has revised Sec. 122.32(a) to clarify that discharges are regulated under today's rule if they are from a small MS4 that is in an urbanized area and has not received a waiver or they are designated by the permitting authority. Today's rule does not regulate the county, city, or town. Today's rule regulates the MS4. Therefore, even though a county may be listed in Appendix 6, if that county does not own or operate the municipal storm sewer systems, the county does not have to submit an application or develop a storm water management program. If another entity does own or operate an MS4 within the county, for example, a regional utility district, that other entity needs to submit the application and develop the program.

Some commenters suggested that EPA should change the rule language to specifically allow regional authorities to be the permitted entity and to allow small MS4s to apply as co-permittees. EPA believes that the best way to clarify that regional authorities can be the primary permitted entity is the change to Sec. 122.32(a) and the explanation above. Because EPA assumes that today's regulation will be implemented through general permits, MS4s will not be co-permittees under a general permit in the same manner as under individual permits. EPA has added Sec. 122.33(a)(4) and made a minor change to Sec. 122.35(a) to clarify that small MS4s can work together to share the responsibilities of a storm water management program. This is discussed further in Section II.H.3.c.iv below.

The proposed rule stated that when a county or Federal Indian reservation is only partially included in an urbanized area, only MS4s in the urbanized portion of the county or Federal Indian reservation would be regulated. In the rare cases when an incorporated place is only partially included in the urbanized area, the entire incorporated place would be regulated. EPA received comments asking about towns and

[[Page 68751]]

townships, because they were not considered to be incorporated areas according to the Census Bureau's definition. Would the whole town/township be covered or only the part of the town/township in the urbanized area? States use many different types of systems in their geographical divisions. Some towns are similar to incorporated cities and others are large areas that are more similar to counties. Some commenters thought that the urbanized area boundary was arbitrary, and if part of a town or county was covered, it all should be covered. Other commenters noted that some townships and counties encompass very large areas of which only a small portion is urbanized. Due to the great variety of situations, EPA has decided that for all geographical entities, only MS4s in the urbanized area are automatically designated. The population densities associated with the Census Bureau's designation of urbanized areas provide the basis for designation of these areas to protect water quality. This focused designation provides for consistency and allows for flexibility on the part of the MS4 and the permitting authority. In those situations where an incorporated place or a town is not all in an ``urbanized area'', there is a good possibility that it is served by more than one MS4. In those cases where the area is served by the same MS4, it makes sense to develop a storm water program for the whole area. Permitting authorities may also decide to designate all MS4s within a county or township, if they believe it is necessary to protect water quality.

Most operators of MS4s will not need to independently determine the status of coverage under today's rule. EPA has revised the proposed Appendices 6 and 7 to include towns and townships. Therefore, these appendices will alert most MS4s as to whether they are likely to be covered under today's rule. However, each permitting authority must make the decision as to who requires coverage. Most likely, an illustrative list of the regulated areas will be published with the general permit. If not, the operator can contact its permitting authority or the Bureau of the Census to find out if their separate storm sewer systems are within an urbanized area.

i. Urbanized Area Description. Under the Bureau of the Census definition of ``urbanized area,'' adopted by EPA for the purposes of today's final rule, ``an urbanized area (UA) comprises a place and the adjacent densely settled surrounding territory that together have a minimum population of 50,000 people.'' The proposal to today's rule provided the full definition and case studies to help explain the census category of ``urbanized area.'' Appendix 2 is a simplified urbanized area illustration to help demonstrate the concept of urbanized areas in relation to today's final rule. The ``urbanized area'' is the shaded area that includes within its boundaries incorporated places, a portion of a Federal Indian reservation, portions of two counties, an entire town, and portions of another town. All small MS4s located in the shaded area are covered by the rule, unless and until waived by the permitting authority. Any small MS4s located outside of the shaded area are subject to potential designation by the permitting authority.

There are 405 urbanized areas in the United States that cover 2 percent of total U.S. land area and contain approximately 63 percent of the nation's population (see Appendix 3 for a listing of urbanized areas of the United States and Puerto Rico). These numbers include U.S. Territories, although Puerto Rico is the only territory to have Census-designated urbanized areas. Urbanized areas constitute the largest and most dense areas of settlement. The purpose of determining an ``urbanized area'' is to delineate the boundaries of development and map the actual built-up urban area. The Bureau of the Census geographers liken it to flying over an urban area and drawing a line around the boundary of the built-up area as seen from the air.

Using data from the latest decennial census, the Census Bureau applies the urbanized area definition nationwide (including U.S. Tribes and Territories) and determines which places and counties are included within each urbanized area. For each urbanized area, the Bureau provides full listings of who is included, as well as detailed maps and special CD-ROM files for use with computerized mapping systems (such as GIS). Each State's data center receives a copy of the list, and some maps, automatically. The States also have the CD-ROM files and a variety of publications available to them for reference from the Bureau of the Census. In addition, local or regional planning agencies may have urbanized area files already. New listings for urbanized areas based on the 2000 Census will be available by July/August 2001, but the more comprehensive computer files will not be available until late 2001/early 2002.

Additional designations based on subsequent census years will be governed by the Bureau of the Census' definition of an urbanized area in effect for that year. Based on historical trends, EPA expects that any area determined by the Bureau of the Census to be included within an urbanized area as of the 1990 Census will not later be excluded from the urbanized area as of the 2000 Census. However, it is important to note that even if this situation were to occur, for example, due to a possible change in the Bureau of the Census' urbanized area definition, a small MS4 that is automatically designated into the NPDES program for storm water under an urbanized area calculation for any given Census year will remain regulated regardless of the results of subsequent urbanized area calculations.

ii. Rationale for Using Urbanized Areas. EPA is using urbanized areas to automatically designate regulated small MS4s on a nationwide basis for several reasons: (1) studies and data show a high correlation between degree of development/ urbanization and adverse impacts on receiving waters due to storm water (U.S. EPA, 1983; Driver et al., 1985; Pitt, R.E. 1991. ``Biological Effects of Urban Runoff Discharges.'' Presented at the Engineering Foundation Conference: Urban Runoff and Receiving Systems; An Interdisciplinary Analysis of Impact, Monitoring and Management, August 1991. Mt. Crested Butte, CO. American Society of Civil Engineers, New York. 1992.; Pitt, R.E. 1995. ``Biological Effects of Urban Runoff Discharges,'' in Storm water Runoff and Receiving Systems: Impact, Monitoring, and Assessment. Lewis Publishers, New York.; Galli, J. 1990. Thermal Impacts Associated with Urbanization and Storm water Management Best Management Practices. Prepared for the Sediment and Storm water Administration of the Maryland Department of the Environment.; Klein, 1979), (2) the blanket coverage within the urbanized area encourages the watershed approach and addresses the problem of ``donut-holes,'' where unregulated areas are surrounded by areas currently regulated (storm water discharges from donut hole areas present a problem due to their contributing uncontrolled adverse impacts on local waters, as well as by frustrating the attainment of water quality goals of neighboring regulated communities), (3) this approach targets present and future growth areas as a preventative measure to help ensure water quality protection, and (4) the determination of urbanized areas by the Bureau of the Census allows operators of small MS4s to quickly determine whether they are included in the NPDES storm water program as a regulated small MS4.

Urbanized areas have experienced significant growth over the past 50 years. According to EPA calculations

[[Page 68752]]

based on Census data from 1980 to 1990, the national average rate of growth in the United States during that 10-year period was more than 4 percent. For the same period, the average growth within urbanized areas was 15.7 percent and the average for outside of urbanized areas was just more than 1 percent. The new development occurring in these growing areas can provide some of the best opportunities for implementing cost-effective storm water management controls.

EPA received many comments on the proposal to designate discharges based on location within urbanized areas. EPA considered numerous other approaches, several of which are discussed in the proposal to today's final rule. Several commenters wanted designation to be based on proven water quality problems rather than inclusion in an urbanized area. One commenter proposed an approach based on the CWA 303(d) listing of impaired waters and the wasteload allocation conducted under the TMDL process. (See section II.L. on the section 303(d) and TMDL process). The commenter's proposal would designate small MS4s on a case-by-case basis, covering only those discharges where receiving streams are shown to have water quality problems, particularly a failure to meet water quality standards, including designated uses. The commenter further described a non-NPDES approach where a State would require cost-effective measures based on a proportionate share under a waste load allocation, equitably allocated among all pollutant contributors. These waste load allocations would be developed with input from all stakeholders, and remedial measures would be implemented in a phased manner based on the probability of results and/or economic feasibility. The States would then periodically reassess the receiving streams to determine whether the remedial measures are working, and if not, require additional control measures using the same procedure used to establish the initial measures. What the commenter describes is almost a TMDL.

EPA considered a remedial approach based on water quality impairment and rejected it for failure to prevent almost certain degradation caused by urban storm water. EPA's main concern in opting not to take a case-by-case approach to designation was that this approach would not provide controls for storm water discharges in receiving streams until after a site-specific demonstration of adverse water quality impact. The commenter's suggestion would do nothing to prevent pollution in waters that may be meeting water quality standards, including supporting designated uses. The approach would also rely on identifying storm water management programs following comprehensive watershed plans and TMDL development. In most States, water quality assessments have traditionally been conducted for principal mainstream rivers and their major tributaries, not all surface waters. The establishment of TMDLs nationwide will take many years, and many States will conduct additional monitoring to determine water quality conditions prior to establishing TMDLs. In addition, a case-by-case approach would not address the problem of ``donut holes'' within urbanized areas and a lack of consistency among similarly situated municipal systems would remain commonplace. After careful consideration of all comments, EPA still believes that the approach in today's rule is the most appropriate to protect water quality. Protection includes prevention as well as remediation.

d. Municipal Designation by the Permitting Authority

Today's final rule also allows NPDES permitting authorities to designate MS4s that should be included in the storm water program as regulated small MS4s but are not located within urbanized areas. The final rule requires, at a minimum, that a set of designation criteria be applied to all small MS4s within a jurisdiction that serves a population of at least 10,000 and has a population density of at least 1,000. Appendix 7 to this preamble provides an illustrative list of places that the Agency anticipates meet this criteria. In addition, any small MS4 may be the subject of a petition to the NPDES permitting authority for designation. See Section II.G, NPDES Permitting Authority's Role for more details on the designation and petition processes. EPA believes that the approach of combining nationwide and local designation to determine municipal coverage balances the potential for significant adverse impacts on water quality with local watershed protection and planning efforts.

e. Waiving the Requirements for Small MS4s

Today's final rule includes some flexibility in the nationwide coverage of all small MS4s located in urbanized areas by providing the NPDES permitting authority with the discretion to waive the otherwise applicable requirements of the smallest MS4s that are not causing the impairment of a receiving water body. Qualifications for the waiver vary depending on whether the MS4 serves a population under 1,000 or a population between 1,000 and 10,000. Note that even if a small MS4 has requirements waived, it can subsequently be brought back into the program if circumstances change. See Section II.G, NPDES Permitting Authority's Role, for more details on this process.

3. Municipal Permit Requirements

a. Overview

i. Summary of Permitting Options. Today's rule outlines six minimum control measures that constitute the framework for a storm water discharge control program for regulated small MS4s that, when properly implemented, will reduce pollutants to the maximum extent practicable (MEP). These six minimum control measures are specified in Sec. 122.34(b) and are discussed below in section ``II.H.3.b, Program Requirements-Minimum Control Measures.'' All operators of regulated small MS4s are required to obtain coverage under an NPDES permit, unless the requirement is waived by the permitting authority in accordance with today's rule. Implementation of Sec. 122.34(b) may be required either through an individual permit or, if the State or EPA makes one available to the facility, through a general permit. The process for issuing and obtaining these permits is discussed below in section ``II.H.3.c, Application Requirements.''

As an alternative to implementing a program that complies with the requirements of Sec. 122.34, today's rule provides operators of regulated small MS4s with the option of applying for an individual permit under Sec. 122.26(d). The permit application requirements in Sec. 122.26 were originally drafted to apply to medium and large MS4s. Although EPA believes that the requirements of Sec. 122.34 provide a regulatory option that is appropriate for most small MS4s, the operators of some small MS4s may prefer more individualized requirements. This alternative permitting option for regulated small MS4s that wish to develop their own program is discussed below in section ``II.H.3.c.iii. Alternative Permit Option.'' The second alternative permitting option for regulated small MS4s is to become co-permittees with a medium or large MS4 regulated under Sec. 122.26(d), as discussed below in section ``II.H.3.c.v. Joint Permit Programs.''

ii. Water Quality-Based Requirements. Any NPDES permit issued under today's rule must, at a minimum, require the operator to develop, implement, and

[[Page 68753]]

enforce a storm water management program designed to reduce the discharge of pollutants from a regulated system to the MEP, to protect water quality, and satisfy the appropriate water quality requirements of the Clean Water Act (see MEP discussion in the following section). Absent evidence to the contrary, EPA presumes that a small MS4 program that implements the six minimum measures in today's rule does not require more stringent limitations to meet water quality standards. Proper implementation of the measures will significantly improve water quality. As discussed further below, however, small MS4 permittees should modify their programs if and when available information indicates that water quality considerations warrant greater attention or prescriptiveness in specific components of the municipal program. If the program is inadequate to protect water quality, including water quality standards, then the permit will need to be modified to include any more stringent limitations necessary to protect water quality.

Regardless of the basis for the development of the effluent limitations (whether designed to implement the six minimum measures or more stringent or prescriptive limitations to protect water quality), EPA considers narrative effluent limitations requiring implementation of BMPs to be the most appropriate form of effluent limitations for MS4s. CWA section 402(p)(3)(b)(iii) expresses a preference for narrative rather than numeric effluent limits, for example, by reference to ``management practices, control techniques and system, design and engineering methods, and such other provisions as the Administrator or the State determines appropriate for the control of such pollutants.'' 33 U.S.C. 1342(p)(3)(B)(iii). EPA determines that pollutants from wet weather discharges are most appropriately controlled through management measures rather than end-of-pipe numeric effluent limitations. As explained in the Interim Permitting Policy for Water Quality-Based Effluent Limitations in Storm Water Permits, issued on August 1, 1996 [61 FR 43761 (November 26, 1996), EPA believes that the currently available methodology for derivation of numeric water quality-based effluent limitations is significantly complicated when applied to wet weather discharges from MS4s (compared to continuous or periodic batch discharges from most other types of discharge). Wet weather discharges from MS4s introduce a high degree of variability in the inputs to the models currently available for derivation of water quality based effluent limitations, including assumptions about instream and discharge flow rates, as well as effluent characterization. In addition, EPA anticipates that determining compliance with any such numeric limitations may be confounded by practical limitations in sample collection.

In the first two to three rounds of permit issuance, EPA envisions that a BMP-based storm water management program that implements the six minimum measures will be the extent of the NPDES permit requirements for the large majority of regulated small MS4s. Because the six measures represent a significant level of control if properly implemented, EPA anticipates that a permit for a regulated small MS4 operator implementing BMPs to satisfy the six minimum control measures will be sufficiently stringent to protect water quality, including water quality standards, so that additional, more stringent and/or more prescriptive water quality based effluent limitations will be unnecessary.

If a small MS4 operator implements the six minimum control measures in Sec. 122.34(b) and the discharges are determined to cause or contribute to non-attainment of an applicable water quality standard, the operator needs to expand or better tailor its BMPs within the scope of the six minimum control measures. EPA envisions that this process will occur during the first two to three permit terms. After that period, EPA will revisit today's regulations for the municipal separate storm sewer program.

If the permitting authority (rather than the regulated small MS4 operator) needs to impose additional or more specific measures to protect water quality, then that action will most likely be the result of an assessment based on a TMDL or equivalent analysis that determines sources and allocations of pollutant(s) of concern. EPA believes that the small MS4's additional requirements, if any, should be guided by its equitable share based on a variety of considerations, such as cost effectiveness, proportionate contribution of pollutants, and ability to reasonably achieve wasteload reductions. Narrative effluent limitations in the form of BMPs may still be the best means of achieving those reductions.

See Section II.L, Water Quality Issues, for further discussion of this approach to permitting, consistent with EPA's interim permitting guidance. Pursuant to CWA section 510, States implementing their own NPDES programs may develop more stringent or more prescriptive requirements than those in today's rule.

EPA's interpretation of CWA section 402(p)(3)(B)(iii) was recently reviewed by the Ninth Circuit in Defenders of Wildlife, et al v. Browner, No. 98-71080 (September 15, 1999). The Court upheld the Agency's action in issuing five MS4 permits that included water quality-based effluent limitations. The Court did, however, disagree with EPA's interpretation of the relationship between CWA sections 301 and 402(p). The Court reasoned that MS4s are not compelled by section 301(b)(1)(C) to meet all State water quality standards, but rather that the Administrator or the State may rely on section 402(p)(3)(B)(iii) to require such controls. Accordingly, the Defenders of Wildlife decision is consistent with the Agency's 1996 ``Interim Permitting Policy for Water Quality-Based Effluent Limitations in Storm Water Permits.''

As noted, the 1996 Policy describes how permits would implement an iterative process using BMPs, assessment, and refocused BMPs, leading toward attainment of water quality standards. The ultimate goal of the iteration would be for water bodies to support their designated uses. EPA believes this iterative approach is consistent with and implements section 301(b)(1)(C), notwithstanding the Ninth Circuit's interpretation. As an alternative to basing these water quality-based requirements on section 301(b)(1)(C), however, EPA also believes the iterative approach toward attainment of water quality standards represents a reasonable interpretation of CWA section 402(p)(3)(B)(iii). For this reason, today's rule specifies that the ``compliance target'' for the design and implementation of municipal storm water control programs is ``to reduce pollutants to the maximum extent practicable (MEP), to protect water quality, and to satisfy the appropriate water quality requirements of the CWA.'' The first component, reductions to the MEP, would be realized through implementation of the six minimum measures. The second component, to protect water quality, reflects the overall design objective for municipal programs based on CWA section 402(p)(6). The third component, to implement other applicable water quality requirements of the CWA, recognizes the Agency's specific determination under CWA section 402(p)(3)(B)(iii) of the need to achieve reasonable further progress toward attainment of water quality standards according to the iterative BMP process, as well as the determination that State or EPA officials who establish TMDLs could allocate waste loads to

[[Page 68754]]

MS4s, as they would to other point sources.

EPA does not presume that water quality will be protected if a small MS4 elects not to implement all of the six minimum measures and instead applies for alternative permit limits under Sec. 122.26(d). Operators of such small MS4s that apply for alternative permit limits under Sec. 122.26(d) must supply additional information through individual permit applications so that the permit writer can determine whether the proposed program reduces pollutants to the MEP and whether any other provisions are appropriate to protect water quality and satisfy the appropriate water quality requirements of the Clean Water Act.

iii. Maximum Extent Practicable. Maximum extent practicable (MEP) is the statutory standard that establishes the level of pollutant reductions that operators of regulated MS4s must achieve. The CWA requires that NPDES permits for discharges from MS4s ``shall require controls to reduce the discharge of pollutants to the maximum extent practicable, including management practices, control techniques and system, design and engineering methods.'' CWA Section 402(p)(3)(B)(iii). This section also calls for ``such other provisions as the [EPA] Administrator or the State determines appropriate for the control of such pollutants.'' EPA interprets this standard to apply to all MS4s, including both existing regulated (large and medium) MS4s, as well as the small MS4s regulated under today's rule.

For regulated small MS4s under today's rule, authorization to discharge may be under either a general permit or individual permit, but EPA anticipates and expects that general permits will be the most common permit mechanism. The general permit will explain the steps necessary to obtain permit authorization. Compliance with the conditions of the general permit and the series of steps associated with identification and implementation of the minimum control measures will satisfy the MEP standard. Implementation of the MEP standard under today's rule will typically require the permittee to develop and implement appropriate BMPs to satisfy each of the required six minimum control measures.

In issuing the general permit, the NPDES permitting authority will establish requirements for each of the minimum control measures. Permits typically will require small MS4 permittees to identify in their NOI the BMPs to be performed and to develop the measurable goals by which implementation of the BMPs can be assessed. Upon receipt of the NOI from a small MS4 operator, the NPDES permitting authority will have the opportunity to review the NOI to verify that the identified

BMPs and measurable goals are consistent with the requirement to reduce pollutants under the MEP standard, to protect water quality, and to satisfy the appropriate water quality requirements of the Clean Water Act. If necessary, the NPDES permitting authority may ask the permittee to revise their mix of BMPs, for example, to better reflect the MEP pollution reduction requirement. Where the NPDES permit is not written to implement the minimum control measures specified under Sec. 122.34(b), for example in the case of an individual permit under Sec. 122.33(b)(2)(ii), the MEP standard will be applied based on the best professional judgment of the permit writer.

Commenters argued that MEP is, as yet, an undefined term and that EPA needs to further clarify the MEP standards by providing a regulatory definition that includes recognition of cost considerations and technical feasibility. Commenters argued that, without a definition, the regulatory community is not adequately on notice regarding the standard with which they need to comply. EPA disagrees that affected MS4 permittees will lack notice of the applicable standard. The framework for the small MS4 permits described in this notice provides EPA's interpretation of the standard and how it should be applied.

EPA has intentionally not provided a precise definition of MEP to allow maximum flexibility in MS4 permitting. MS4s need the flexibility to optimize reductions in storm water pollutants on a location-by-location basis. EPA envisions that this evaluative process will consider such factors as conditions of receiving waters, specific local concerns, and other aspects included in a comprehensive watershed plan. Other factors may include MS4 size, climate, implementation schedules, current ability to finance the program, beneficial uses of receiving water, hydrology, geology, and capacity to perform operation and maintenance.

The pollutant reductions that represent MEP may be different for each small MS4, given the unique local hydrologic and geologic concerns that may exist and the differing possible pollutant control strategies. Therefore, each permittee will determine appropriate BMPs to satisfy each of the six minimum control measures through an evaluative process. Permit writers may evaluate small MS4 operator's proposed storm water management controls to determine whether reduction of pollutants to the MEP can be achieved with the identified BMPs.

EPA envisions application of the MEP standard as an iterative process. MEP should continually adapt to current conditions and BMP effectiveness and should strive to attain water quality standards. Successive iterations of the mix of BMPs and measurable goals will be driven by the objective of assuring maintenance of water quality standards. If, after implementing the six minimum control measures there is still water quality impairment associated with discharges from the MS4, after successive permit terms the permittee will need to expand or better tailor its BMPs within the scope of the six minimum control measures for each subsequent permit. EPA envisions that this process may take two to three permit terms.

One commenter observed that MEP is not static and that if the six minimum control measures are not achieving the necessary water quality improvements, then an MS4 should be expected to revise and, if necessary, expand its program. This concept, it is argued, must be clearly part of the definition of MEP and thus incorporated into the binding and operative aspects of the rule. As is explained above, EPA believes that it is. The iterative process described above is intended to be sensitive to water quality concerns. EPA believes that today's rule contains provisions to implement an approach that is consistent with this comment.

b. Program Requirements'Minimum Control Measures

A regulated small MS4 operator must develop and implement a storm water management program designed to reduce the discharge of pollutants from their MS4 to protect water quality. The storm water management program must include the following six minimum measures.

i. Public Education and Outreach on Storm Water Impacts. Under today's final rule, operators of small MS4s must implement a public education program to distribute educational materials to the community or conduct equivalent outreach activities about the impacts of storm water discharges on water bodies and the steps to reduce storm water pollution. The public education program should inform individuals and households about the problem and the steps they can take to reduce or prevent storm water pollution.

EPA believes that as the public gains a greater understanding of the storm water program, the MS4 is likely to gain

[[Page 68755]]

more support for the program (including funding initiatives). In addition, compliance with the program will probably be greater if the public understands the personal responsibilities expected of them. Well-informed citizens can act as formal or informal educators to further disseminate information and gather support for the program, thus easing the burden on the municipalities to perform all educational activities.

MS4s are encouraged to enter into partnerships with their States in fulfilling the public education requirement. It may be more cost-effective to utilize a State education program instead of numerous MS4s developing their own programs. MS4 operators are also encouraged to work with other organizations (e.g., environmental, nonprofit and industry organizations) that might be able to assist in fulfilling this requirement.

The public education program should be tailored, using a mix of locally appropriate strategies, to target specific audiences and communities (particularly minority and disadvantaged communities). Examples of strategies include distributing brochures or fact sheets, sponsoring speaking engagements before community groups, providing public service announcements, implementing educational programs targeted at school age children, and conducting community-based projects such as storm drain stenciling, and watershed and beach cleanups. Operators of MS4s may use storm water educational information provided by the State, Tribe, EPA, or environmental, public interest, trade organizations, or other MS4s. Examples of successful public education efforts concerning polluted runoff can be found in many State nonpoint source pollution control programs under CWA section 319.

The public education program should inform individuals and households about steps they can take to reduce storm water pollution, such as ensuring proper septic system maintenance, ensuring the use and disposal of landscape and garden chemicals including fertilizers and pesticides, protecting and restoring riparian vegetation, and properly disposing of used motor oil or household hazardous wastes. Additionally, the program could inform individuals and groups on how to become involved in local stream and beach restoration activities as well as activities coordinated by youth service and conservation corps and other citizen groups. Finally, materials or outreach programs should be directed toward targeted groups of commercial, industrial, and institutional entities likely to have significant storm water impacts. For example, MS4 operators should provide information to restaurants on the impact of grease clogging storm drains and to auto garages on the impacts of used oil discharges.

EPA received comments from representatives of State DOTs and U.S.

Department of Defense (DOD) installations seeking exemption from the public education requirement. While today's rule does not exempt DOTs and military bases from the user education requirement, the Agency believes the flexibility inherent in the Rule addresses many of the concerns expressed by these commenters.

Certain DOT representatives commented that if their agencies were not exempt from the user education measure's requirements, they should at least be allowed to count DOT employee education as an adequate substitute. EPA supports the use of existing materials and programs, granted such materials and programs meet the rule's requirement that the MS4 user community (i.e., the public) is also educated concerning the impacts of storm water discharges on water bodies and the steps to reduce storm water pollution.

Finally, certain DOD representatives requested that ``public,'' as applied to their installations, be defined as the resident and employee populations within the fence line of the facility. EPA agrees that the education effort should be directed toward those individuals who frequent the federally owned land (i.e., residents and individuals who come there to work and use the MS4 facilities).

EPA also received a number of comments from municipalities stating that education would be more thorough and cost effective if accomplished by EPA on the national level. EPA believes that a collaborative State and local approach, in conjunction with significant EPA technical support, will best meet the goal of targeting, and reaching, specific local audiences. EPA technical support will include a tool box which will contain fact sheets, guidance documents, an information clearinghouse, and training and outreach efforts.

Finally, EPA received comments expressing concern that the public education program simply encourages the distribution of printed material. EPA is sensitive to this concern. Upon evaluation, the Agency made changes to the proposal's language for today's rule. The language has been changed to reflect EPA's belief that a successful program is one that includes a variety of strategies locally designed to reach specific audiences.

ii. Public Involvement/Participation. Public involvement is an integral part of the small MS4 storm water program. Accordingly, today's final rule requires that the municipal storm water management program must comply with applicable State and local public notice requirements. Section 122.34(b)(2) recommends a public participation process with efforts to reach out and engage all economic and ethnic groups. EPA believes there are two important reasons why the public should be allowed and encouraged to provide valuable input and assistance to the MS4's program.

First, early and frequent public involvement can shorten implementation schedules and broaden public support for a program. Opportunities for members of the public to participate in program development and implementation could include serving as citizen representatives on a local storm water management panel, attending public hearings, working as citizen volunteers to educate other individuals about the program, assisting in program coordination with other pre-existing programs, or participating in volunteer monitoring efforts. Moreover, members of the public may be less likely to raise legal challenges to a MS4's storm water program if they have been involved in the decision making process and program development and, therefore, internalize personal responsibility for the program themselves.

Second, public participation is likely to ensure a more successful storm water program by providing valuable expertise and a conduit to other programs and governments. This is particularly important if the MS4's storm water program is to be implemented on a watershed basis.

Interested stakeholders may offer to volunteer in the implementation of all aspects of the program, thus conserving limited municipal resources.

EPA recognizes that there are a number of challenges associated with public involvement. One challenge is in engaging people in the public meeting and program design process. Another challenge is addressing conflicting viewpoints. Nevertheless, EPA strongly believes that these challenges can be addressed by use of an aggressive and inclusive program. Section II.K. provides further discussion on public involvement.

A number of municipalities sought clarification from EPA concerning what the public participation program must

[[Page 68756]]

actually include. In response, the actual requirements are minimal, but the Agency's recommendations are more comprehensive. The public participation program must only comply with applicable State and local public notice requirements. The remainder of the preamble, as well as the Explanatory Note accompanying the regulatory text, provide guidance to the MS4s concerning what elements a successful and inclusive program should include. EPA will provide technical support as part of the tool box (i.e., providing model public involvement programs, conducting public workshops, etc.) to assist MS4 operators meet the intent of this measure.

Finally, the Agency encourages MS4s to seek public participation prior to submitting an NOI. For example, public participation at this stage will allow the MS4 to involve the public in developing the BMPs and measurable goals for their NOI.

iii. Illicit Discharge Detection and Elimination. Discharges from small MS4s often include wastes and wastewater from non-storm water ``illicit'' discharges. Illicit discharge is defined at 40 CFR 122.26(b)(2) as any discharge to a municipal separate storm sewer that is not composed entirely of storm water, except discharges pursuant to an NPDES permit and discharges resulting from fire fighting activities. As detailed below, other sources of non-storm water, that would otherwise be considered illicit discharges, do not need to be addressed unless the operator of the MS4 identifies one or more of them as a significant source of pollutants into the system. EPA's Nationwide Urban Runoff Program (NURP) indicated that many storm water outfalls still discharge during substantial dry periods. Pollutant levels in these dry weather flows were shown to be high enough to significantly degrade receiving water quality. Results from a 1987 study conducted in Sacramento, California, revealed that slightly less than one-half of the water discharged from a municipal separate storm sewer system was not directly attributable to precipitation runoff (U.S. Environmental Protection Agency, Office of Research and Development. 1993. Investigation of Inappropriate Pollutant Entries Into Storm Drainage Systems--A User's Guide. Washington, DC EPA 600/R-92/238.) A significant portion of these dry weather flows results from illicit and/or inappropriate discharges and connections to the municipal separate storm sewer system. Illicit discharges enter the system through either direct connections (e.g., wastewater piping either mistakenly or deliberately connected to the storm drains) or indirect connections (e.g., infiltration into the storm drain system or spills collected by drain inlets).

Under the existing NPDES program for storm water, permit applications for large and medium MS4s are to include a program description for effective prohibition against non-storm water discharges into their storm sewers (see 40 CFR 122.26 (d)(1)(v)(B) and (d)(1)(iv)(B)). Further, EPA believes that in implementing municipal storm water management plans under these permits, large and medium MS4 operators generally found their illicit discharge detection and elimination programs to be cost-effective. Properly implemented programs also significantly improved water quality.

In today's rule, any NPDES permit issued to an operator of a regulated small MS4 must, at a minimum, require the operator to develop, implement and enforce an illicit discharge detection and elimination program. Inclusion of this measure for regulated small MS4s is consistent with the ``effective prohibition'' requirement for large and medium MS4s. Under today's rule, the NPDES permit will require the operator of a regulated small MS4 to: (1) Develop (if not already completed) a storm sewer system map showing the location of all outfalls, and names and location of all waters of the United States that receive discharges from those outfalls; (2) to the extent allowable under State, Tribal, or local law, effectively prohibit through ordinance, or other regulatory mechanism, illicit discharges into the separate storm sewer system and implement appropriate enforcement procedures and actions as needed; (3) develop and implement a plan to detect and address illicit discharges, including illegal dumping, to the system; and (4) inform public employees, businesses, and the general public of hazards associated with illegal discharges and improper disposal of waste.

The illicit discharge and elimination program need only address the following categories of non-storm water discharges if the operator of the small MS4 identifies them as significant contributors of pollutants to its small MS4: water line flushing, landscape irrigation, diverted stream flows, rising ground waters, uncontaminated ground water infiltration (as defined at 40 CFR 35.2005(20)), uncontaminated pumped ground water, discharges from potable water sources, foundation drains, air conditioning condensation, irrigation water, springs, water from crawl space pumps, footing drains, lawn watering, individual residential car washing, flows from riparian habitats and wetlands, dechlorinated swimming pool discharges, and street wash water (discharges or flows from fire fighting activities are excluded from the definition of illicit discharge and only need to be addressed where they are identified as significant sources of pollutants to waters of the United States). If the operator of the MS4 identifies one or more of these categories of sources to be a significant contributor of pollutants to the system, it could require specific controls for that category of discharge or prohibit the discharges completely.

Several comments were received on the mapping requirements of the proposal. Most comments said that more flexibility should be given to the MS4s to determine their mapping needs, and that resources could be better spent in addressing problems once the illicit discharges are detected. EPA reviewed the mapping requirements in the proposed rule and agrees that some of the information is not necessary in order to begin an illicit discharge detection and elimination program. Today's rule requires a map or set of maps that show the locations of all outfalls and names and locations of receiving waters. Knowing the locations of outfalls and receiving waters are necessary to be able to conduct dry weather field screening for non-storm water flows and to respond to illicit discharge reports from the public. EPA recommends that the operator collect any existing information on outfall locations (e.g., review city records, drainage maps, storm drain maps), and then conduct field surveys to verify the locations. It will probably be necessary to ``walk'' (i.e. wade small receiving waters or use a boat for larger receiving waters) the streambanks and shorelines, and it may take more than one trip to locate all outfalls. A coding system should be used to mark and identify each outfall. MS4 operators have the flexibility to determine the type (e.g. topographic, GIS, hand or computer drafted) and size of maps which best meet their needs. The map scale should be such that the outfalls can be accurately located. Once an illicit discharge is detected at an outfall, it may be necessary to map that portion of the storm sewer system leading to the outfall in order to locate the source of the discharge.

Several comments requested clarification of the requirement to develop and implement a plan to detect and eliminate illicit discharges. EPA recommends that plans include procedures for the following: locating priority areas; tracing the source of an illicit discharge; removing the source of the discharge; and program evaluation

[[Page 68757]]

and assessment. EPA recommends that MS4 operators identify priority areas (i.e., problems areas) for more detailed screening of their system based on higher likelihood of illicit connections (e.g., areas with older sanitary sewer lines), or by conducting ambient sampling to locate impacted reaches. Once priority areas are identified, EPA recommends visually screening outfalls during dry weather and conducting field tests, where flow is occurring, of selected chemical parameters as indicators of the discharge source. EPA's manual for investigation of inappropriate pollutant entries into the storm drainage system (EPA, 1993) suggests the following parameter list: specific conductivity, fluoride and/or hardness concentration, ammonia and/or potassium concentration, surfactant and/or fluorescence concentration, chlorine concentration, pH and other chemicals indicative of industrial sources. The manual explains why each parameter is a good indicator and how the information can be used to determine the type of source flow. The Agency is not recommending that fluoride and chlorine, generally used to locate potable water discharges, be addressed under this program, therefore a short list of parameters may include conductivity, ammonia, surfactant and pH. Some MS4s have found it useful to measure for fecal coliform or E. coli in their testing program. Observations of physical characteristics of the discharge are also helpful such as flow rate, temperature, odor, color, turbidity, floatable matter, deposits and stains, and vegetation.

The implementation plan should also include procedures for tracing the source of an illicit discharge. Once an illicit discharge is detected and field tests provide source characteristics, the next step is to determine the actual location of the source. Techniques for tracing the discharge to its place of origin may include: following the flow up the storm drainage system via observations and/or chemical testing in manholes or in open channels; televising storm sewers; using infrared and thermal photography; conducting smoke or dye tests.

The implementation plan should also include procedures for removing the source of the illicit discharge. The first step may be to notify the property owner and specify a length of time for eliminating the discharge. Additional notifications and escalating legal actions should also be described in this part of the plan.

Finally, the implementation plan should include procedures for program evaluation and assessment. Procedures could include documentation of actions taken to locate and eliminate illicit discharges such as: number of outfalls screened, complaints received and corrected, feet of storm sewers televised, numbers of discharges and quantities of flow eliminated, number of dye or smoke tests conducted. Appropriate records of such actions should be kept and should be submitted as part of the annual reports for the first permit term, as specified by the permitting authority (reports only need to be submitted in years 2 and 4 in later permits). For more on reporting requirements, see Sec. 122.34(g).

EPA received comments regarding an MS4's legal authority beyond its jurisdictional boundaries to inspect or take enforcement against illicit discharges. EPA recognizes that illicit flows may originate in one jurisdiction and cross into one or more jurisdictions before being discharged at an outfall. In such instances, EPA expects the MS4 that detects the illicit flow to trace it to the point where it leaves their jurisdiction and notify the adjoining MS4 of the flow, and any other physical or chemical information. The adjoining MS4 should then trace it to the source or to the location where it enters their jurisdiction. The process of notifying the adjoining MS4 should continue until the source is located and eliminated. In addition, because any non-storm water discharge to waters of the U.S. through an MS4 is subject to the prohibition against unpermitted discharges pursuant to CWA section 301 (a), remedies are available under the federal enforcement provisions of CWA sections 309 and 505.

EPA requested and received comments regarding the prohibition and enforcement provision for this minimum measure. Commenters specifically questioned the proposal that the operator only has to implement the appropriate prohibition and enforcement procedures ``to the extent allowable under State or Tribal law.'' They raised concerns that by qualifying prohibition and enforcement procedures in this manner, the operator could altogether ignore this minimum measure where affirmative legal authority did not exist. Comments suggested that EPA require States to grant authority to those municipalities where it did not exist. Other comments, however, stated that municipalities cannot exercise legal authority not granted to them under State law, which varies considerably from one State to another. EPA has no intention of directing State legislatures on how to allocate authority and responsibility under State law. As noted above, there is at least one remedy (the federal CWA) to control non-storm water discharges through MS4s. If State law prevents political subdivisions from controlling discharges through storm sewers, EPA anticipates common sense will prevail to provide those MS4 operators with the ability to meet the requirements applicable for their discharges.

One comment reinforced the importance of public information and education to the success of this measure. EPA agrees and suggests that MS4 operators consider a variety of ways to inform and educate the public which could include storm drain stenciling; a program to promote, publicize, and facilitate public reporting of illicit connections or discharges; and distribution of visual and/or printed outreach materials. Recycling and other public outreach programs could be developed to address potential sources of illicit discharges, including used motor oil, antifreeze, pesticides, herbicides, and fertilizers.

EPA received comments that State DOT's lack authority to implement this measure. EPA believes that most DOTs can implement most parts of this measure. If a DOT does not have the necessary legal authority to implement any part of this measure, EPA encourages them to coordinate their storm water management efforts with the surrounding MS4s and other State agencies. Many DOTs that are regulated under Phase I of this program are co-permittees with the local regulated MS4. Under today's rule, DOTs can use any of the options of Sec. 122.35 to share their storm water management responsibilities.

EPA received comments requesting clarification of various terms such as ``outfall'' and ``illicit discharge.'' One comment asked EPA to reinforce the point that a ``ditch'' could be considered an outfall. The term ``outfall'' is defined at 40 CFR 122.26(b)(9) as ``a point source at the point where a municipal separate storm sewer discharges to waters of the United States * * *''. The term municipal separate storm sewer is defined at 40 CFR Sec. 122.26(b)(8) as ``a conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains) * * *''. Following the logic of these definitions, a ``ditch'' may be part of the municipal separate storm sewer, and at the point where the ditch discharges to waters of the United States, it would be an outfall. As with any determination about jurisdictional provisions of the CWA, however, final decisions require case specific evaluations of fact.

[[Page 68758]]

One commenter specifically requested clarification on the relationship between the term ``illicit discharge'' and non-storm water discharges from fire fighting. The comment suggested that it would be impractical to attempt to determine whether the flow from a specific fire (i.e., during a fire) is a significant source of pollution. EPA intends that MS4s will address all allowable non-storm water flows categorically rather than individually. If an MS4 is concerned that flows from fire fighting are, as a category, contributing substantial amounts of pollutants to their system, they could develop a program to address those flows prospectively. The program may include an analysis of the flow from several sources, steps to minimize the pollutant contribution, and a plan to work with the sources of the discharge to minimize any adverse impact on water quality. During the development of such a program, the MS4 may determine that only certain types of flows within a particular category are a concern, for example, fire fighting flows at industrial sites where large quantities of chemicals are present. In this example, a review of existing procedures with the fire department and/or hazardous materials team may reveal weaknesses or strengths previously unknown to the MS4 operator.

EPA received comments requesting modifications to the rule to include on-site sewage disposal systems (i.e., septic systems) in the scope of the illicit discharge program. On-site sewage disposal systems that flow into storm drainage systems are within the definition of illicit discharge as defined by the regulations. Where they are found to be the source of an illicit discharge, they need to be eliminated similar to any other illicit discharge source. Today's rule was not modified to include discharges from on-site sewage disposal systems specifically because those sources are already within the scope of the existing definition of illicit discharge.

iv. Construction Site Storm Water Runoff Control. Over a short period of time, storm water runoff from construction site activity can contribute more pollutants, including sediment, to a receiving stream than had been deposited over several decades (see section I.B.3). Storm water runoff from construction sites can include pollutants other than sediment, such as phosphorus and nitrogen, pesticides, petroleum derivatives, construction chemicals, and solid wastes that may become mobilized when land surfaces are disturbed. Generally, properly implemented and enforced construction site ordinances effectively reduce these pollutants. In many areas, however, the effectiveness of ordinances in reducing pollutants is limited due to inadequate enforcement or incomplete compliance with such local ordinances by construction site operators (Paterson, R.G. 1994. ``Construction Practices: The Good, the Bad, and the Ugly.'' Watershed Protection Techniques 1(2)).

Today's rule requires operators of regulated small MS4s to develop, implement, and enforce a pollutant control program to reduce pollutants in any storm water runoff from construction activities that result in land disturbance of 1 or more acres (see Sec. 122.34(b)(4)).

Construction activity on sites disturbing less than one acre must be included in the program if the construction activity is part of a larger common plan of development or sale that would disturb one acre or more.

The construction runoff control program of the regulated small MS4 must include an ordinance or other regulatory mechanism to require erosion and sediment controls to the extent practicable and allowable under State, Tribal or local law. The program also must include sanctions to ensure compliance (for example, non-monetary penalties, fines, bonding requirements, and/or permit denials for non-compliance). The program must also include, at a minimum, requirements for construction site operators to implement appropriate erosion and sediment control BMPS, such as silt fences, temporary detention ponds and diversions; procedures for site plan review by the small MS4 which incorporate consideration of potential water quality impacts; requirements to control other waste such as discarded building materials, concrete truck washout, chemicals, litter, and sanitary waste at the construction site that may adversely impact water quality; procedures for receipt and consideration of information submitted by the public to the MS4; and procedures for site inspection and enforcement of control measures by the small MS4.

Today's rule provides flexibility for regulated small MS4s by allowing them to exclude from their construction pollutant control program runoff from those construction sites for which the NPDES permitting authority has waived NPDES storm water small construction permit requirements. For example, if the NPDES permitting authority waives permit coverage for storm water discharges from construction sites less than 5 acres in areas where the rainfall erosivity factor is less than 5, then the regulated small MS4 does not have to include these sites in its storm water management program. Even if requirements for a discharge from a given construction site are waived by the NPDES permitting authority, however, the regulated small MS4 may still chose to control those discharges under the MS4's construction pollutant control program, particularly where such discharges may cause siltation problems in storm sewers. See Section II.I.1.b for more information on construction waivers by the permitting authority.

Some commenters suggested that the proposed construction minimum measure requirements went beyond the permit application requirements concerning construction for medium and large MS4s. In response, EPA has made changes to the proposed measure so that it more closely resembles the MS4 permit application requirements in existing regulations. For example, as described below, the Agency revised the proposed requirements for ``pre-construction review of site management plans'' to require ``procedures for site plan review.''

One commenter expressed concerns that addressing runoff from construction sites within urbanized areas (through the small MS4 program) differently from construction sites outside urbanized areas (which will not be covered by the small MS4 program) will encourage urban sprawl. Today's rule, together with the existing requirements, requires all construction greater than or equal to 1 acre, unless waived, to be covered by an NPDES permit whether it is located inside or outside of an urbanized area (see Sec. 122.26(b)(15)). Today's rule does not require small MS4s to control runoff from construction sites more stringently or prescriptively than is required for construction site runoff outside urbanized areas. Therefore, today's rule imposes no substantively different onsite controls on runoff of storm water from construction sites in urbanized areas than from construction sites outside of urbanized areas.

One commenter recommended that the small MS4 construction site storm water runoff control program address all storm water runoff from construction sites, not just the runoff into the MS4. The commenter also believed that MS4s should provide clear, objective standards for all construction sites. EPA agrees. Because today's rule only regulates discharges from the MS4, the construction pollutant control measure only requires small MS4 operators to control runoff into its system. As a practical matter, however, EPA anticipates that MS4 operators will find that regulation of all construction site

[[Page 68759]]

runoff, whether they runoff into the MS4 or not, will prove to be the most simple and efficient program. The Agency may provide more specific criteria for construction site BMPs in the forthcoming rule being developed under CWA section 402(m). See section II.D.1 of today's rule.

One commenter stated that there is no need for penalties at the local level by the small MS4 because the CWA already imposes sufficient penalties to ensure compliance. EPA disagrees and believes that enforcement and compliance at the local level is both necessary and preferable. Examples of sanctions, some not available under the CWA, include non-monetary penalties, monetary fines, bonding requirements, and denial of future or other local permits.

One commenter recommended that EPA should not include the requirement to control pollutants other than sediment from construction sites in this measure. EPA disagrees with this comment. The requirement is to control waste that ``may cause adverse impacts on water quality.'' Such wastes may include discarded building materials, concrete truck washout, chemicals, pesticides, herbicides, litter, and sanitary waste. These wastes, when exposed to and mobilized by storm water, can contribute to water quality impairment.

The proposed rule required ``procedures for pre-construction review of site management plans.'' EPA requested comment on expanding this provision to require both review and approval of construction site storm water plans. Many commenters expressed the concern that review and approval of site plans is not only costly and time intensive, but may unnecessarily delay construction projects and unduly burden staff who administer the local program. In addition, some commenters expressed confusion whether EPA proposed pre-construction review for all site management plans or only higher priority sites. To address these comments, and be consistent with the permit application requirements for larger MS4s, EPA changed ``procedures for pre-construction review of site management plans'' to ``procedures for site plan review.'' Today's rule requires the small MS4 to develop procedures for site plan review so as to incorporate consideration of adverse potential water quality impacts. Procedures should include review of site erosion and sediment control plans, preferably before construction activity begins on a site. The objective is for the small MS4 operator and the construction site operator to address storm water runoff from construction activity early in the project design process so that potential consequences to the aquatic environment can be assessed and adverse water quality impacts can be minimized or eliminated.

One commenter requested that EPA delete the requirement for ``procedures for receipt and consideration of information submitted by the public'' because it went beyond existing storm water requirements. Another commenter stated that establishing a separate process to respond to public inquiries on a project is a burden to small communities, especially if the project has gone through an environmental review. One commenter requested clarification of this provision. EPA has retained this requirement in today's final rule to require some formality in the process for addressing public inquiries regarding storm water runoff from construction activities. EPA does not intend that small MS4s develop a separate, burdensome process to respond to every public inquiry. A small MS4 could, for example, simply log public complaints on existing storm water runoff problems from construction sites and pass that information on to local inspectors. The inspectors could then investigate complaints based on the severity of the violation and/or priority area.

One commenter believed that the proposed requirement of ``regular inspections during construction'' would require every construction project to be inspected more than once by the small MS4 during the term of a construction project. EPA has deleted the reference to ``regular inspections.'' Instead, the small MS4 will be required to ``develop procedures for site inspection and enforcement of control measures.'' Procedures could include steps to identify priority sites for inspection and enforcement based on the nature and extent of the construction activity, topography, and the characteristics of soils and receiving water quality.

In order to avoid duplication of small MS4 construction requirements with NPDES construction permit requirements, today's rule adds Sec. 122.44(s) to recognize that the NPDES permitting authority can incorporate qualifying State, Tribal, or local erosion and sediment control requirements in NPDES permits for construction site discharges. For example, a construction site operator who complies with MS4 construction pollutant control programs that are referenced in the NPDES construction permit would satisfy the requirements of the NPDES permit. See section II.I.1.d for more information on incorporating qualifying programs by reference into NPDES construction permits. This provision has no impact on, or direct relation to, the small MS4 operator's responsibilities under the construction site storm water runoff control minimum measure. Conversely, under Sec. 122.35(b), the permitting authority may recognize in the MS4's permit that another governmental entity, or the permitting authority itself, is responsible for implementing one or more of the minimum measures (including construction site storm water runoff control), and not include this measure in the small MS4's permit. In this case, the other governmental entity's program must satisfy all of the requirements of the omitted measure.

v. Post-Construction Storm Water Management in New Development and Redevelopment. The NURP study and more recent investigations indicate that prior planning and designing for the minimization of pollutants in storm water discharges is the most cost-effective approach to storm water quality management. Reducing pollutant concentrations in storm water after the discharge enters a storm sewer system is often more expensive and less efficient than preventing or reducing pollutants at the source. Increased human activity associated with development often results in increased pollutant loading from storm water discharges. If potential adverse water quality impacts are considered from the beginning stages of a project, new development and redevelopment provides more opportunities for water quality protection. For example, minimization of impervious areas, maintenance or restoration of natural infiltration, wetland protection, use of vegetated drainage ways, and use of riparian buffers have been shown to reduce pollutant loadings in storm water runoff from developed areas. EPA encourages operators of regulated small MS4s to identify specific problem areas within their jurisdictions and initiate innovative solutions and designs to focus attention on those areas through local planning.

In today's rule at Sec. 122.34(b)(5), NPDES permits issued to an operator of a regulated small MS4 will require the operator to develop, implement, and enforce a program to address storm water runoff from new development and redevelopment projects that result in land disturbance of greater than or equal to one acre, including projects less than one acre that are part of a larger common plan of development or sale, that discharge into the MS4. Specifically, the NPDES permit will require the operator of a regulated small MS4 to: (1) Develop and implement

[[Page 68760]]

strategies which include a combination of structural and/or non-structural best management practices (BMPs) appropriate for the community; (2) use an ordinance, or other regulatory mechanism to address post-construction runoff from new development and redevelopment projects to the extent allowable under State, Tribal or local law; (3) ensure adequate long-term operation and maintenance of BMPs; and (4) ensure that controls are in place that would minimize water quality impacts. EPA intends the term ``redevelopment'' to refer to alterations of a property that change the ``footprint'' of a site or building in such a way that results in the disturbance of equal to or greater than 1 acre of land. The term is not intended to include such activities as exterior remodeling, which would not be expected to cause adverse storm water quality impacts and offer no new opportunity for storm water controls.

EPA received comments requesting guidance and clarification of the rule requirements. The scope of the comments ranged from general requests for more details on how MS4 operators should accomplish the four requirements listed above, to specific requests for information regarding transfer of ownership for structural controls, as well as ongoing responsibility for operation and maintenance. By the term ``combination'' of BMPs, EPA intends a combination of structural and/or non-structural BMPs. For this requirement, the term ``combination'' is meant to emphasize that multiple BMPs should be considered and adopted for use in the community. A single BMP generally cannot significantly reduce pollutant loads because pollutants come from many sources within a community. The BMPs chosen should: (1) Be appropriate for the local community; (2) minimize water quality impacts; and (3) attempt to maintain pre-development runoff conditions. In choosing appropriate BMPs, EPA encourages small MS4 operators to participate in locally-based watershed planning efforts which attempt to involve a diverse group of stakeholders. Each new development and redevelopment project should have a BMP component. If an approach is chosen that primarily focuses on regional or non-structural BMPs, however, then the BMPs may be located away from the actual development site (e.g., a regional water quality pond).

Non-structural BMPs are preventative actions that involve management and source controls such as: (1) Policies and ordinances that provide requirements and standards to direct growth to identified areas, protect sensitive areas such as wetlands and riparian areas, maintain and/or increase open space (including a dedicated funding source for open space acquisition), provide buffers along sensitive water bodies, minimize impervious surfaces, and minimize disturbance of soils and vegetation; (2) policies or ordinances that encourage infill development in higher density urban areas, and areas with existing storm sewer infrastructure; (3) education programs for developers and the public about project designs that minimize water quality impacts; and (4) other measures such as minimization of the percentage of impervious area after development, use of measures to minimize directly connected impervious areas, and source control measures often thought of as good housekeeping, preventive maintenance and spill prevention. Detailed examples of non-structural BMPs follow.

Preserving open space may help to protect water quality as well as provide other benefits such as recharging groundwater supplies, detaining storm water, supporting wildlife and providing recreational opportunities. Although securing funding for open space acquisition may be difficult, various funding mechanisms have been used. New Jersey uses a portion of their State sales tax (voter approved for a ten year period) as a stable source of funding to finance the preservation of historic sites, open space and farmland. Colorado uses part of the proceeds from the State lottery to acquire and manage open space. Some local municipalities use a percentage of the local sales tax revenue to pay for open space acquisition (e.g., Jefferson County, CO has had an open space program in place since 1977 funded by a 0.50 percent sales tax). Open space can be acquired in the form of: fee simple purchase; easements; development rights; purchase and sellback or leaseback arrangements; purchase options; private land trusts; impact fees; and land dedication requirements. Generally, fee simple purchases provide the highest level of development control and certainty of preservation, whereas the other forms of acquisition may provide less control, though they would also generally be less costly.

Cluster development, while allowing housing densities comparable to conventional zoning practice, concentrates housing units in a portion of the total site area which provides for greater open space, recreation, stream protection and storm water control. This type of development, by reducing lot sizes, can protect sensitive areas and result in less impervious surface, as well as reduce the cost for roads and other infrastructure.

Minimizing directly connected impervious areas (DCIAs) is a drainage strategy that seeks to reduce paved areas and directs storm water runoff to landscaped areas or to structural controls such as grass swales or buffer strips. This strategy can slow the rate of runoff, reduce runoff volumes, attenuate peak flows, and encourage filtering and infiltration of storm water. It can be made an integral part of drainage planning for any development (Urban Drainage and Flood Control District, Denver, CO. 1992. Urban Storm Drainage Criteria Manual, Volume 3--Best Management Practices). The Urban Drainage and Flood Control District manual describes three levels for minimizing DCIAs. At Level 1 all impervious surfaces are made to drain over grass-covered areas before reaching a storm water conveyance system. Level 2 adds to Level 1 and replaces street curb and gutter systems with low-velocity grass-lined swales and pervious street shoulders. In addition to Levels 1 and 2, Level 3 over-sizes swales and configures driveway and street crossing culverts to use grass-lined swales as elongated detention basins.

Structural BMPs include: (1) Storage practices such as wet ponds and extended-detention outlet structures; (2) filtration practices such as grassed swales, sand filters and filter strips; and (3) infiltration practices such as infiltration basins and infiltration trenches.

EPA recommends that small MS4 operators ensure the appropriate implementation of the structural BMPs by considering some or all of the following: (1) Pre-construction review of BMP designs; (2) inspections during construction to verify BMPs are built as designed; (3) post-construction inspection and maintenance of BMPs; and (4) sanctions to ensure compliance with design, construction or operation and maintenance (O&M) requirements of the program.

EPA cautions that certain infiltration systems such as dry wells, bored wells or tile drainage fields may be subject to Underground Injection Control (UIC) program requirements (see 40 CFR Part 144.12.). To find out more about these requirements, contact your state UIC Program, or call EPA's Safe Drinking Water Hotline at 1-800-426-4791.

In order to meet the third post-construction requirement (ensuring adequate long-term O&M of BMPs), EPA recommends that small MS4 operators evaluate various O&M management agreement options. The most common options are agreements between the

[[Page 68761]]

MS4 operator and another party such as post-development landowners (e.g., homeowners' associations, office park owners, other government departments or entities), or regional authorities (e.g., flood control districts, councils of government). These agreements typically require the post-construction property owner to be responsible for the O&M and may include conditions which: allow the MS4 operator to be reimbursed for O&M performed by the MS4 operator that is the responsibility of the property owner but is not performed; allow the MS4 operator to enter the property for inspection purposes; and in some cases specify that the property owner submit periodic reports.

In providing the guidance above, EPA intends the requirements in today's rule to be consistent with the permit application requirements for large MS4s for post-construction controls for new development and redevelopment. MS4 operators have significant flexibility both to develop this measure as appropriate to address local concerns, and to apply new control technologies as they become available. Storm water pollution control technologies are constantly being improved. EPA recommends that MS4s be responsive to these changes, developments or improvements in control technologies. EPA will provide more detailed guidance addressing the responsibility for long-term O&M of storm water controls in guidance materials. The guidance will also provide information on appropriate planning considerations, structural controls and non-structural controls. EPA also intends to develop a broad menu of BMPs as guidance to ensure flexibility to accommodate local conditions.

EPA received comments suggesting that requirements for new development be treated separately from redevelopment in the rule. The comment stressed that new development on raw land presents fewer obstacles and more opportunities to incorporate elements for preventing water quality impacts, whereas redevelopment projects are constrained by space limitations and existing infrastructure. Another comment suggested allowing waivers from the redevelopment requirements if the redevelopment does not result in additional adverse water quality impacts, and where BMPs are not technologically or economically feasible. EPA recognizes that redevelopment projects may have more site constraints which narrow the range of appropriate BMPs. Today's rule provides small MS4 operators with the flexibility to develop requirements that may be different for redevelopment projects, and may also include allowances for alternate or off-site BMPs at certain redevelopment projects. Non-structural BMPs may be the most appropriate approach for smaller redevelopment projects.

EPA received comments requesting clarification on what is meant by ``pre-development'' conditions within the context of redevelopment. Pre-development refers to runoff conditions that exist onsite immediately before the planned development activities occur. Pre-development is not intended to be interpreted as that period before any human-induced land disturbance activity has occurred.

EPA received comments on the guidance language in the proposed rule and preamble which suggest that implementation of this measure should ``attempt to maintain pre-development runoff conditions'' and that ``post-development conditions should not be different than pre-development conditions in a way that adversely affects water quality.'' Many comments expressed concern that maintaining pre-development runoff conditions is impossible and cost-prohibitive, and objected to any reference to ``flow'' or increase in volume of runoff. Other comments support the inclusion of this language in the final rule. Similar references in today's rule relating to pre-development runoff conditions are intended as recommendations to attempt to maintain pre-development runoff conditions. With these recommendations, EPA intends to prevent water quality impacts resulting from increased discharges of pollutants, which may result from increased volume of runoff. In many cases, consideration of the increased flow rate, velocity and energy of storm water discharges following development unavoidably must be taken into consideration in order to reduce the discharge of pollutants, to meet water quality standards and to prevent degradation of receiving streams. EPA recommends that municipalities consider these factors when developing their post construction storm water management program.

Some comments said that the quoted phrases in the paragraph above are directives that imply federal land use control, which they argue is beyond the authority of the CWA. EPA recognizes that land use planning is within the authority of local governments.

EPA disagrees, however, with the implication that today's rule dictates any such land use decisions. The requirement for small MS4 operators to develop a program to address discharges resulting from new development and redevelopment is essentially a pollution prevention measure. The Rule provides the MS4 operator with flexibility to determine the appropriate BMPs to address local water quality concerns. EPA recognizes that these program goals may not be applied to every site, and expects that MS4s will develop an appropriate combination of BMPs to be applied on a site-by-site, regional or watershed basis.

vi. Pollution Prevention/Good Housekeeping for Municipal Operations. Under today's final rule, operators of MS4s must develop and implement an operation and maintenance program (``program'') that includes a training component and has the ultimate goal of preventing or reducing storm water from municipal operations (in addition to those that constitute storm water discharges associated with industrial activity). This measure's emphasis on proper O&M of MS4s and employee training, as opposed to requiring the MS4 to undertake major new activities, is meant to ensure that municipal activities are performed in the most efficient way to minimize contamination of storm water discharges.

The program must include government employee training that addresses prevention measures pertaining to municipal operations such as: parks, golf courses and open space maintenance; fleet maintenance; new construction or land disturbance; building oversight; planning; and storm water system maintenance. The program can use existing storm water pollution prevention training materials provided by the State, Tribe, EPA, or environmental, public interest, or trade organizations.

EPA also encourages operators of MS4s to consider the following in developing a program: (1) Implement maintenance activities, maintenance schedules, and long-term inspection procedures for structural and non-structural storm water controls to reduce floatables and other pollutants discharged from the separate storm sewers; (2) implement controls for reducing or eliminating the discharge of pollutants from streets, roads, highways, municipal parking lots, maintenance and storage yards, waste transfer stations, fleet or maintenance shops with outdoor storage areas, and salt/sand storage locations and snow disposal areas operated by the MS4; (3) adopt procedures for the proper disposal of waste removed from the separate storm sewer systems and areas listed above in (2), including dredge

[[Page 68762]]

spoil, accumulated sediments, floatables, and other debris; and (4) adopt procedures to ensure that new flood management projects are assessed for impacts on water quality and existing projects are assessed for incorporation of additional water quality protection devices or practices. Ultimately, the effective performance of the program measure depends on the proper maintenance of the BMPs, both structural and non-structural. Without proper maintenance, BMP performance declines significantly over time. Additionally, BMP neglect may produce health and safety threats, such as structural failure leading to flooding, undesirable animal and insect breeding, and odors. Maintenance of structural BMPs could include: replacing upper levels of gravel; dredging of detention ponds; and repairing of retention basin outlet structure integrity. Maintenance of non-structural BMPs could include updating educational materials periodically.

EPA emphasizes that programs should identify and incorporate existing storm water practices and training, as well as non-storm water practices or programs that have storm water pollution prevention benefits, as a means to avoid duplication of efforts and reduce overall costs. EPA recommends that MS4s incorporate these new obligations into their existing programs to the greatest extent feasible and urges States to evaluate MS4 programs with programmatic efficiency in mind. EPA designed this minimum control measure as a modified version of the permit application requirements for medium and large MS4s described at 40 CFR 122.26(d)(2)(iv), in order to provide more flexibility for these smaller MS4s. Today's requirements provide for a consistent approach to control pollutants from O&M among medium, large, and regulated small MS4s.

By properly implementing a program, operators of MS4s serve as a model for the rest of the regulated community. Furthermore, the establishment of a long-term program could result in cost savings by minimizing possible damage to the system from floatables and other debris and, consequently, reducing the need for repairs.

EPA received comments requesting clarification of what this measure requires. Certain municipalities expressed concern that the measure has the potential to impose significant costs associated with EPA's requirement that operators of MS4s consider implementing controls for reducing or eliminating the discharge of pollutants from streets, roads, highways, municipal parking lots, and salt/sand storage locations and snow disposal areas operated by the municipality. EPA disagrees that a requirement to consider such controls will impose considerable costs.

One commenter objected to the preamble language from the proposal suggesting that EPA does not expect the MS4 to undertake new activity. While it remains the Agency's expectation that major new activity will not be required, the MEP process should drive MS4s to incorporate the measure's obligations into their existing programs to achieve the pollutant reductions to the maximum extent practicable.

Certain commenters requested a definition for ``municipal operations.'' EPA has revised the language to more clearly define municipal operations. Questions may remain concerning whether discharges from specific municipal activities constitute discharges associated with industrial activities (requiring NPDES permit authorization according to the requirements for industrial storm water that apply in that State) or from municipal operations (subject only to the controls developed in the MS4 control program). Even though there may be different substantive requirements that apply depending on the source of the discharge, EPA has modified the deadlines for permit coverage so that all the regulated municipally owned and operated sources become subject to permit requirements on the same date. The deadline is the same for permit coverage for this minimum measure as for permit coverage for municipally owned/operated industrial sources.

c. Application Requirements

An NPDES permit that authorizes the discharge from a regulated small MS4 may take the form of either an individual permit issued to one or more facilities as co-permittees or a general permit that applies to a group of MS4s. For reasons of administrative efficiency and to reduce the paperwork burden on permittees, EPA expects that most discharges from regulated small MS4s will be authorized under general permits. These NPDES general permits will provide specific instructions on how to obtain coverage, including application requirements. Typically, such application requirements will be satisfied by the submission of a Notice of Intent (NOI) to be covered by the general permit. In this section, EPA explains the small MS4 operator's application requirements for obtaining coverage under an NPDES permit for storm water.

i. Best Management Practices and Measurable Goals, Section 122.34(d) of today's rule requires the operator of a regulated small MS4 that wishes to implement a program under Sec. 122.34 to identify and submit to the NPDES permitting authority a list of the best management practices (``BMPs'') that will be implemented for each minimum control measure in their storm water management program. They also must submit measurable goals for the development and implementation of each BMP. The BMPs and the measurable goals must be included either in an NOI to be covered under a general permit or in an individual permit application.

The operator's submission must identify, as appropriate, the months and years in which the operator will undertake actions required to implement each of the minimum control measures, including interim milestones and the frequency of periodic actions. The Agency revised references to ``starting and completing'' actions from the proposed rule because many actions will be repetitive or ongoing. The submission also must identify the person or persons responsible for implementing or coordinating the small MS4 storm water program. See Sec. 122.34(d). The submitted BMPs and measurable goals become enforceable according to the terms of the permit. The first permit can allow the permittee up to five years to fully implement the storm water management program.

Several commenters opposed making the measurable goals enforceable permit conditions. Some suggested that a permittee should be able to change its goals so that BMPs that are not functioning as intended can be replaced. EPA agrees that a permittee should be free to switch its BMPs and corresponding goals to others that accomplish the minimum measure or measures. The permittee is required to implement BMPs that address the minimum measures in Sec. 122.34(b). If the permittee determines that its original combination of BMPs are not adequate to achieve the objectives of the municipal program, the MS4 should revise its program to implement BMPs that are adequate and submit to the permitting authority a revised list of BMPs and measurable goals. EPA suggests that permits describe the process for revising BMPs and measurable goals, such as whether the permittee should follow the same procedures as were required for the submission of the original NOI and whether the permitting authority's approval is necessary prior to the permittee implementing the revised

[[Page 68763]]

BMPs. The permittee should indicate on its periodic report whether any BMPs and measurable goals have been revised since the last periodic report.

Some commenters expressed concern that making the measurable goals enforceable would encourage the development of easily attained goals and, conversely, discourage the setting of ambitious goals. Others noted that it is often difficult to determine the pollutant reduction that can be achieved by BMPs until several years after implementation.

Much of the opposition to the enforceability of measurable goals appears to have been based on a mistaken understanding that measurable goals must consist of pollutant reduction targets to be achieved by the corresponding BMPs.

Today's rule requires the operator to submit either measurable goals that serve as BMP design objectives or goals that quantify the progress of implementation of the actions or performance of the permittee's BMPs. At a minimum, the required measurable goals should describe specific actions taken by the permittee to implement each BMP and the frequency and the dates for such actions. Although the operator may choose to do so, it is not required to submit goals that measure whether a BMP or combination of BMPs is effective in achieving a specific result in terms of storm water discharge quality. For example, a measurable goal might involve a commitment to inspect a given number of drainage areas of the collection system for illicit connections by a certain date. The measurable goal need not commit to achieving a specific amount of pollutant reduction through the elimination of illicit connections. Other measurable goals could include the date by which public education materials would be developed, a certain percentage of the community participating in a clean-up campaign, the development of a mechanism to address construction site runoff, and a reduction in the percentage of imperviousness associated with new development projects.

To reduce the risk that permittees will develop inadequate BMPs, EPA intends to develop a menu of BMPs to assist the operators of regulated small MS4s with the development of municipal programs. States may also develop a menu of BMPs. Today's rule provides that the measurable goals that demonstrate compliance with the minimum control measures in Secs. 122.34 (b)(3) through (b)(6) do not have to be met if the State or EPA has not issued a menu of BMPs at the time the MS4 submits its NOI. Commenters pointed out that the proposed rule would have made the measurable goals unenforceable if the menu of BMPs was not available, but the proposal was silent as to the enforceability of the implementation of BMPs. Today's rule clarifies that the operators are not free to do nothing prior to the issuance of a menu of BMPs; they still must make a good faith effort to implement the BMPs designed to comply with each measure. See Sec. 122.34(d)(2). The operators would not, however, be liable for failure to meet its measurable goals if a menu of BMPs was not available at the time they submit their NOI.

The proposed rule provision in Sec. 123.35 stated that the ``[f]ailure to issue the menu of BMPs would not affect the legal status of the general permit.'' This concept is included in the final rule in Sec. 122.34(d)(2)'s clarification that the permittee still must comply with other requirements of the general permit.

Unlike the proposed rule, today's rule does not require that each BMP in the menu developed by the State or EPA be regionally appropriate, cost-effective and field-tested. Various commenters criticized those criteria as unworkable, and one described them as ``ripe for ambiguity and abuse.'' Other commenters feared that the operators of regulated small MS4s would never be required to achieve their goals until menus were developed that were cost-effective, field-tested and appropriate for every conceivable subregion.

While some municipal commenters supported the requirement that a menu of BMPs be made available that included BMPs that had been determined to be regionally appropriate, field-tested and cost-effective, others raised concerns that they would be restricted to a limited menu. Some commenters supported such a detailed menu because they thought they would only be able to select BMPs that were on the menu, while others thought that it was the permitting authority's responsibility to develop BMPs narrowly tailored to their situation. In response, EPA notes that the operators will not be restricted to implementing only, or all of, the BMPs included on the menu. Since the menu does not require permittees to implement the BMPs included on the menu, it is also not necessary to apply the public notice and other procedures that some commenters thought should be applied to the development of the menu of BMPs.

The purpose of the BMP menu is to provide guidance to assist the operators of regulated small MS4s with the development and refinement of their local program, not to limit their options. Permittees may implement BMPs other than those on the menu unless a State restricts its permittees to specific BMPs. To the extent possible, EPA will develop a menu of BMPs that describes the appropriateness of BMPs to specific regions, whether the BMPs have been field-tested, and their approximate costs. The menu, however, is not intended to relieve permittees of the need to implement BMPs that are appropriate for their specific circumstances.

If there are no known relevant BMPs for a specific circumstance, a permittee has the option of developing and implementing pilot BMPs that may be better suited to their circumstances. Where BMPs are experimental, the permittee should consider committing to measurable goals that address its schedule for implementing its selected BMPs rather than goals of achieving specific pollutant reductions. If the BMPs implemented by the permittee do not achieve the desired objective, the permittee may be required to commit to different or revised BMPs.

As stated in Sec. 123.35(g), EPA is committed to issuing a menu of BMPs prior to the deadline for the issuance of permits. This menu would serve as guidance for all operators of regulated small MS4s nationwide. After developing the initial menu of BMPs, EPA intends to periodically modify, update, and supplement the menu of BMPs based on the assessments of the MS4 storm water program and research. States may rely on EPA's menu of BMPs or issue their own. If States develop their own menus, they would constitute additional guidance (or perhaps requirements in some States) for the operators to follow. Several commenters were confused by the proposed rule language that stated that States must provide or issue a menu of BMPs and, if they fail to do so, EPA ``may'' do so. Some read this language as not requiring either EPA or the State to develop the menu. EPA had intended that it would develop a menu and that States could either provide the EPA developed menu or one developed by the State.

EPA has dropped the proposed language that States ``must'' develop the menu of BMPs. Some commenters thought that it was inappropriate to require States to issue guidance. A menu of BMPs issued by either EPA or a permittee's State will satisfy the condition in Sec. 122.34(d) that a regulatory authority provide a menu of BMPs. A State could require its permittees to follow its menu of BMPs provided that they are adequate to implement Sec. 122.34(b).

Several commenters raised concerns that operators of small MS4s could be

[[Page 68764]]

required to submit their BMPs and measurable goals before EPA or the State has issued a menu of BMPs. EPA has assumed primary responsibility for developing a menu of BMPs to minimize the possibility of this occurring. Should a general permit be issued before a menu of BMPs is available, the permit writer would have the option of delaying the date by which the identification of the BMPs and measurable goals must be submitted to the permitting authority until some time after a menu of BMPs is available.

Several municipal commenters raised concerns that they would begin to develop a program only to be later told by the permitting authority or challenged in a citizen suit that their BMPs were inadequate. They expressed a need for certainty regarding what their permit required. Several commenters suggested that EPA require permitting authorities to approve or disapprove the submitted BMPs and measurable goals. EPA disagrees that formal approval or disapproval by the permitting authority is needed.

EPA acknowledges that the lack of a formal approval process does place on the permittee some responsibility for designing and determining the adequacy of its BMPs. Once the permittee has submitted its BMPs to the permitting authority as part of its NOI, it must implement them in order to achieve the corresponding measurable goals. EPA does not believe that this results in the uncertainty to the extent expressed by some commenters or unduly expose the permittee to the risk of citizen suit. If the permit is very specific regarding what the permittee must do, then the uncertainty is eliminated. If the permit is less prescriptive, the permittee has greater latitude in determining for itself what constitutes an adequate program. A citizen suit could impose liability on the permittee only if the program that it develops and implements clearly does not satisfy the requirements of the general permit. EPA believes today's approach strikes a balance between the competing goals of providing certainty as to what constitutes an adequate program and providing flexibility to the permittees.

Commenters were divided on whether five years was a reasonable and expeditious schedule for a MS4 to implement its program. Some thought that it was an appropriate amount of time to allow for the development and implementation of adequate programs. One questioned whether the permittee had to be implementing all of its program within that time, and suggested that there may be cases where a permitting authority would need flexibility to allow more time. One commenter suggested that five years is too long and would amount to a relaxation of implementation in their area. EPA believes it will take considerable time to complete the tasks of initially developing a program, commencing to implement it, and achieving results. EPA notes, however, that full implementation of an appropriate program must occur as expeditiously as possible, and not later than five years.

EPA solicited comment on how an NOI form might best be formatted to allow for measurable goal information (e.g., through the use of check boxes or narrative descriptions) while taking into account the Agency's intention to facilitate computer tracking. All commenters supported the development of a checklist NOI, but most noted that there would need to be room for additional information to cover unusual situations. One noted that, while a summary of measurable goals might be reduced to one sheet, attachments that more fully described the program and the planned BMPs would be necessary. EPA agrees that in most cases a ``checklist'' will not be able to capture the information on what BMPs a permittee intends to implement and its measurable goals for their implementation. EPA will continue to consider whether to develop a model NOI form and make it available for permitting authorities that choose to use it. What will be required on an MS4's NOI, however, is more extensive than what is usually required on an NOI, so a ``form'' NOI for MS4s may be impractical.

ii. Individual Permit Application for a Sec. 122.34(b) program. In some cases, an operator of a regulated small MS4s may seek coverage under an individual NPDES permit, either because it chooses to do so or because the NPDES permitting authority has not made the general permit option available to that source. For small MS4s that are to implement a Sec. 122.34(b) program in today's rule, EPA is promulgating simplified individual permit application requirements at Sec. 122.33(b)(2)(i). Under the simplified individual permit application requirements, the operator submits an application to the NPDES permitting authority that includes the information required under Sec. 122.21(f) and an estimate of square mileage served by the small MS4. They are also required to supply the BMP and measurable goal information required under Sec. 122.34(d). Consistent with CWA section 308 and analogous State law, the permitting authority could request any additional information to gain a better understanding of the system and the areas draining into the system.

Commenters suggested that the requirements of Sec. 122.21(f) are not necessarily applicable to a small MS4. One suggested that it was not appropriate to require the following information: a description of the activities conducted by the applicant which require it to obtain an NPDES permit; the name, mailing address, and location of the facility; and up to four Standard Industrial Classification (``SIC'') codes which best reflect the principal products or services provided by the facility. In response, EPA notes that the requirements in Sec. 122.21(f) are generic application requirements applicable to NPDES applicants. With the exception of the SIC code requirement, EPA believes that they are applicable to MS4s. In the SIC code portion of the standard application, the applicant may simply put ``not applicable.''

One commenter asked that EPA clarify whether Sec. 122.21(f)(5)'s requirement to indicate ``whether the facility is located on Indian lands,'' referred to tribal lands, Indian country, or Indian reservations. For some local governments this is a complex issue with no easy ``yes'' or ``no'' answer. See the discussion in the Section II.F in the proposal to today's rule regarding what tribal lands are subject to the federal trust responsibility for purposes of the NPDES program.

One commenter suggested that the application should not have to list the permits and approvals required under Sec. 122.21(f)(6). EPA notes that the applicant must only list the environmental permits that the applicant has received that cover the small MS4. The applicant is not required to list permits for other operations conducted by the small MS4 operator (e.g., for an operation of an airport or landfill). Again, in most cases the applicant could respond ``not applicable'' to this portion of the application.

One commenter suggested that the topographic map requirement of Sec. 122.21(f)(7) was completely different from, and significantly more onerous than, the mapping requirement outlined in the proposed rule at Sec. 122.34(b)(3)(i). EPA agrees and has modified the final rule to clarify that a map that satisfies the requirements of Sec. 122.34(b)(3)(i) also satisfies the map requirements for MS4 applicants seeking individual permits under Sec. 122.33(b)(2)(i).

EPA is adding a new paragraph to Sec. 122.44(k) to clarify that requirements to implement BMPs developed pursuant to CWA 402(p) are appropriate permit

[[Page 68765]]

conditions. While such conditions could be included under the existing provision in Sec. 122.44(k)(3) for ``practices reasonably necessary to achieve effluent limitations and standards or to carry out the purposes and intent of the CWA,'' EPA believes it is clearer to specifically list in Sec. 122.44(k) BMPs that implement storm water programs in light of the frequency with which they are used as effluent limitations.

iii. Alternative Permit Options/Tenth Amendment. As an alternative to implementing a program that addresses each of the six minimum measures according to the requirements of Sec. 122.34(b), today's rule provides the operators of regulated small MS4s with the option of applying for an individual permit under existing Sec. 122.26(d). See Sec. 122.33(b)(2)(ii). If a system operator does not want to be held accountable for implementation of each of the minimum measures, an individual permit option under Sec. 122.33(b)(2)(ii) remains available. (As explained in the next section of this preamble, Sec. 122.35(b) also provides an opportunity for relief from permit obligations for some of the minimum measures, but that relief exists within the framework of the minimum measures.)

EPA originally drafted the individual permit application requirements in Sec. 122.26(d) to apply to medium and large MS4s. Today's rule abbreviates the individual permit application requirements for small MS4s. Although EPA believes that the storm water management program requirements of Sec. 122.34, including the minimum measures, provide the most appropriate means to control pollutants from most small MS4s, the Agency does recognize that the operators of some small MS4s may prefer more individualized permit requirements. Among other possible reasons, an operator may seek to avoid having to ``regulate'' third parties discharging into the separate storm sewer system. Alternatively, an operator may determine that structural controls, such as constructed wetlands, are more appropriate or effective to address the discharges that would otherwise be addressed under the construction and/or development/redevelopment measures.

Some MS4s commenters alleged that an absolute requirement to implement the minimum measures violates the Tenth Amendment to the U.S. Constitution. While EPA disagrees that requiring MS4s to implement the minimum measures would violate the Constitution, today's rule does provide small MS4s with the option of developing more individualized measures to reduce the pollutants and pollution associated with urban storm water that will be regulated under today's rule.

Some commenters specifically objected that Sec. 122.34's minimum measures for small MS4s violate the Tenth Amendment insofar as they require the operators of MS4s to regulate third parties. The minimum measures include requirements for small MS4 operators to prohibit certain non-storm water discharges, control storm water discharges from construction greater than one acre, and take other actions to control third party sources of storm water discharges into their MS4s. Commenters also argued that it was inappropriate for EPA to require local governments to enact ordinances that will consume local revenues and put local governments in the position of bearing the political responsibility for implementing the program. One commenter argued that EPA was prohibited from conditioning the issuance of an NPDES permit upon the small MS4 operators waiving their constitutional right to be free from such requirements to regulate third parties. The Agency replies to each comment in turn.

Because the rule does rely on local governments--who operate municipal separate storm sewer systems--to regulate discharges from third parties into storm sewers, EPA acknowledges that the rule implicates the Tenth Amendment and constitutional principles of federalism. EPA disagrees, however, that today's rule is inconsistent with federalism principles. [As political subdivisions of States, municipalities enjoy the same protections as States under the Tenth Amendment.]

The Supreme Court has interpreted the Tenth Amendment to preclude federal actions that compel States or their political subdivisions to enact or administer a federal regulatory program. See New York v. United States, 505 U.S. 144 (1992); Printz v. United States, 117 S.Ct. 2365 (1997). The Printz case, however, did acknowledge that the restriction does not apply when federal requirements of general applicability--requirements that regulate all parties engaging in a particular activity--do not excessively interfere with the functioning of State governments when those requirements are applied to States (or their political subdivisions). See Printz, 117 S.Ct. at 2383.

Today's rule imposes a federal requirement of general applicability, namely, the requirement to obtain and comply with an NPDES permit, on municipalities that operate a municipal separate storm sewer system. By virtue of this rule, the permit will require the municipality/storm sewer operator to develop a storm water control program. The rule specifies the components of the control program, which are primarily ``management'-type controls, for example, municipal regulation of third party storm water discharges associated with construction, as well as development and redevelopment, when those discharges would enter the municipal system.

Unlike the circumstances reviewed in the New York and Printz cases, today's rule merely applies a generally applicable requirement (the CWA permit requirement) to municipal point sources. The CWA establishes a generally applicable requirement to obtain an NPDES permit to authorize point source discharge to waters of the United States. Because municipalities own and operate separate storm sewers, including storm sewers into which third parties may discharge pollutants, NPDES permits may require municipalities to control the discharge of pollutants into the storm sewers in the first instance. Because NPDES permits can impose end-of-pipe numeric effluent limits, narrative effluent limits in the form of ``management'' program requirements are also within the scope of Clean Water Act authority. As noted above, however, EPA believes that such narrative limitations are the most appropriate form of effluent limitation for these types of permits. For municipal separate storm sewer permits, CWA section 402(p)(3)(B)(iii) specifically authorizes ``controls to reduce pollutants to the maximum extent practicable, including management practices, control techniques and system, design and engineering methods, and such other provisions as the Administrator or the State determines appropriate for the control of such pollutants.''

The Agency did not design the minimum measures in Sec. 122.34 to ``commandeer'' state regulatory mechanisms, but rather to reduce pollutant discharges from small MS4s. The permit requirement in CWA section 402 is a requirement of general applicability. The operator of a small MS4 that does not prohibit and/or control discharges into its system essentially accepts ``title'' for those discharges. At a minimum, by providing free and open access to the MS4s that convey discharges to the waters of the United States, the municipal storm sewer system enables water quality impairment by third parties. Section 122.34 requires the operator of a regulated small MS4 to control a third

[[Page 68766]]

party only to the extent that the MS4 collection system receives pollutants from that third party and discharges it to the waters of the United States. The operators of regulated small MS4s cannot passively receive and discharge pollutants from third parties. The Agency concedes that administration of a municipal program will consume limited local revenues for implementation; but those consequences stem from the municipal operator's identity as a permitted sewer system operator. The Tenth Amendment does not create a blanket municipal immunity from generally applicable requirements. Development of a program based on the minimum measures and implementation of that program should not ``excessively interfere'' with the functioning of municipal government, especially given the ``practicability'' threshold under CWA section 402(p)(3)(B)(iii).

As noted above, today's rule also allows regulated small MS4s to opt out of the minimum measures approach. The individual permit option provides for greater flexibility in program implementation and also responds to the comment about requiring a municipal permit applicant's waiver of any arguable constitutional rights. The individual permit option responds to questions about the rule's alleged unconstitutionality by more specifically focusing on the pollutants discharged from municipal point sources. Today's rule gives operators of MS4s the option to seek an individual permit that varies from the minimum measures/management approach that is otherwise specified in today's rule. Even if the minimum measures approach was constitutionally suspect, a requirement that standing alone would violate constitutional principles of federalism does not raise concerns if the entity subject to the requirement may opt for an alternative action that does not raise a federalism issue.

For municipal system operators who seek to avoid third party regulation according to all or some of the minimum measures, Sec. 122.26(d) requires the operator to submit a narrative description of its storm water sewer system and any existing storm water control program, as well as the monitoring data to enable the permit writer to develop appropriate permit conditions. The permit writer can then develop permit conditions and limitations that vary from the six minimum measures prescribed in today's rule. The information will enable the permit writer to develop an NPDES permit that will result in pollutant reduction to the maximum extent practicable. See NRDC v. EPA, 966 F.2d at 1308, n17. If determined appropriate under CWA section 402(p)(3)(B)(iii), for example BMPs to meet water quality standards, the permit could also incorporate any more stringent or prescriptive effluent limits based on the individual permit application information.

For small MS4 operators seeking an individual permit, both Part 1 and Part 2 of the application requirements in Sec. 122.26(d)(1) and (2) are required to be submitted within 3 years and 90 days of the date of publication of this Federal Register notice. Some of the information required in Part 1 will necessarily have to be developed by the permit applicant prior to the development of Part 2 of the application. The permit applicant should coordinate with its permitting authority regarding the timing of review of the information.

The operators of regulated small MS4s that apply under Sec. 122.26(d) may apply to implement certain of the Sec. 122.34(b) minimum control measures, and thereby focus the necessary evaluation for additional limitations on alternative controls to the Sec. 122.34(b) measures that the small MS4 will not implement. The permit writer may determine ``equivalency'' for some or all of the minimum measures by developing a rough estimate of the pollutant reduction that would be achieved if the MS4 implemented the Sec. 122.34 minimum measure and to incorporate that pollutant reduction estimate in the small MS4's individual permit as an effluent limitation. The Agency recognizes that, based on current information, any such estimates will probably have a wide range. Anticipation of this wide range is one of the reasons EPA believes MS4 operators need flexibility in determining the mix of BMPs (under the minimum measures) to achieve water quality objectives. Therefore, for example, if a system operator seeks to employ an alternative that involves structural controls, wide ranges will probably be associated with gross pollutant reduction estimates. Permit writers will undoubtedly develop other ways to ensure that permit limits ensure reduction of pollutants to the maximum extent practicable.

Small MS4 operators that pursue this individual permit option do not need to submit details about their future program requirements (e.g., the MS4's future plans to obtain legal authority required by Secs. 122.26(d)(1)(ii) and (d)(2)). A small MS4 operator might elect to supply such information if it intends for the permit writer to take those plans into account when developing the small MS4's permit conditions.

Several operators of small MS4s commented that they currently lacked the authority they would need to implement one or more of the minimum measures in Sec. 122.34(b). Today's rule recognizes that the operators of some small MS4s might not have the authority under State law to implement one or more of the measures using, for example, an ordinance or other regulatory mechanism. To address these situations, each minimum measure in Sec. 122.34(b) that would require the small MS4 operator to develop an ordinance or other regulatory mechanism states that the operator is only required to implement that requirement to ``the extent allowable under State, Tribal or local law.'' See Sec. 122.34(b)(3)(ii) (illicit discharge elimination), Sec. 122.34(b)(4)(ii) (construction runoff control) and Sec. 122.34(b)(5)(ii) (post-construction storm water management). This regulatory language does not mean that a operator of a small MS4 with ordinance making authority can simply fail to pass an ordinance necessary for a Sec. 122.34(b) program. The reference to ``the extent allowable under * * * local law'' refers to the local laws of other political subdivisions to which the MS4 operator is subject. Rather, a small MS4 operator that seeks to implement a program under section Sec. 122.34(b) may omit a requirement to develop an ordinance or other regulatory mechanism only to the extent its municipal charter, State constitution or other legal authority prevents the operator from exercising the necessary authority. Where the operator cannot obtain the authority to implement any activity that is only required to ``the extent allowable under State, Tribal or local law,'' the operator may satisfy today's rule by administering the remaining Sec. 122.34(b) requirements.

Finally, although today's rule provides operators of small MS4s with an option of applying for a permit under Sec. 122.26(d), States authorized to administer the NPDES program are not required to provide this option. NPDES-authorized States could require all regulated small MS4s to be permitted under the minimum measures management approach in Sec. 122.34 as a matter of State law. Such an approach would be deemed to be equally or more stringent than what is required by today's rule. See 40 CFR 123.2(i). The federalism concerns discussed above do not apply to requirements imposed by a State on its political subdivisions.

iv. Satisfaction of Minimum Measure Obligations by Another Entity. An operator of a regulated small MS4 may

[[Page 68767]]

satisfy the requirement to implement one or more of the six minimum measures in Sec. 122.34(b) by having a third party implement the measure or measures. Today's rule provides a variety of means for small MS4 operators to share responsibility for different aspects of their storm water management program. The means by which the operators of various MS4s share responsibility may affect who is ultimately responsible for performance of the minimum measure and who files the periodic reports on the implementation of the minimum measure. Section 122.35 addresses these issues. The rule describes two different variants on third party implementation with different consequences if the third party fails to implement the measure.

If the permit covering the discharge from a regulated small MS4 identifies the operator as the entity responsible for a particular minimum control measure, then the operator-permittee remains responsible for the implementation of that measure even if another entity has agreed to implement the control measure. Section 122.35(a). Another party may satisfy the operator-permittee's responsibility by implementing the minimum control measure in a manner at least as stringent or prescriptive as the corresponding NPDES permit requirement. If the third party fails to do so, the operator-permittee remains responsible for its performance. The operator of the MS4 should consider entering into an agreement with the third party that acknowledges the responsibility to implement the minimum measure. The operator-permittee's NOT and its annual Sec. 122.34(f)(3) reports submitted to the NPDES permitting authority must identify the third party that is satisfying one or more of the permit obligations. This requirement ensures that the permitting authority is aware which entity is supposed to implement which minimum measures.

If, on the other hand, the regulated small MS4's permit recognizes that an NPDES permittee other than the operator-permittee is responsible for a particular minimum control measure, then the operator-permittee is relieved from the responsibility for implementing that measure. The operator-permittee is also relieved from the responsibility for implementing any measure that the operator's permit indicates will be performed by the NPDES permitting authority. Section 122.35(b). The MS4 operator-permittee would be responsible for implementing the remaining minimum measures.

Today's final rule differs from the proposed version of Sec. 122.35(b), which stated that, even if the third party's responsibility is recognized in the permit, the MS4 operator-permittee remained responsible for performance if the third party failed to perform the measure consistent with Sec. 122.34(b). Under today's rule, the operator-permittee is relieved from responsibility for performance of a measure if the third party is an NPDES permittee whose permit makes it responsible for performance of the measure (including, for example, a State agency other than the State agency that issues NPDES permits) or if the third party is the NPDES permitting authority itself. Because the permitting authority is acknowledging the third party's responsibility in the permit, commenters thought that the MS4 operator-permittee should not be responsible for ensuring that the other entity is implementing the control measure properly. EPA agrees that the operator-permittee should not be conditionally responsible when the requirements are enforceable against some other NPDES permittee. If the third party fails to perform the minimum measure, the requirements will be enforceable against the third party. In addition, the NPDES permitting authority could reopen the operator-permittee's permit under Sec. 122.62 and modify the permit to make the operator responsible for implementing the measure. A new paragraph has been added to Sec. 122.62 to clarify that the permit may be reopened in such circumstances.

Today's rule also provides that the operator-permittee is not conditionally responsible where it is the State NPDES permitting authority itself that fails to implement the measure. The permitting authority does not need to issue a permit to itself (i.e., to the same State agency that issues the permit) for the sole purpose of relieving the small MS4 from responsibility in the event the State agency does not satisfy its obligation to implement a measure. EPA does not believe that the small MS4 should be responsible in the situation where the NPDES permit issued to the small MS4 operator recognizes that the State agency that issues the permit is responsible for implementing a measure. If the State does fail to implement the measure, the State agency could be held accountable for its commitment in the permit to implement the measure. Where the State does not fulfill its responsibility to implement a measure, a citizen also could petition for withdrawal of the State's NPDES program or it could petition to have the MS4's permit reopened to require the MS4 operator to implement the measure.

EPA notes that not every State program that addresses erosion and sediment control from construction sites will be adequate to satisfy the requirement that each regulated small MS4 have a program to the extent required by Sec. 122.34(b)(4). For example, although all NPDES States are required to issue NPDES permits for construction activity that disturbs greater than one acre, the State's NPDES permit program will not necessarily be extensive enough to satisfy a regulated small MS4's obligation under Sec. 122.34(b)(4). NPDES States will not necessarily be implementing all of the required elements of that minimum measure, such as procedures for site plan review in each jurisdiction required to develop a program and procedures for receipt and consideration of information submitted by the public on individual construction sites. In order for a State erosion and sediment control program to satisfy a small MS4 operator's obligation to implement Sec. 122.34(b)(4), the State program would have to include all of the elements of that minimum measure.

Where the operator-permittee is itself performing one or more of the minimum measures, the operator-permittee remains responsible for all of the reporting requirements under Sec. 122.34(f)(3). The operator-permittee's reports should identify each entity that is performing the control measures within the geographic jurisdiction of the regulated small MS4. If the other entity also operates a regulated MS4 and files reports on the progress of implementation of the measures within the geographic jurisdiction of the MS4, then the operator-permittee need not include that same information in its own reports.

If the other entity operates a regulated MS4 and is performing all of the minimum measures for the permittee, the permittee is not required to file the reports required by Sec. 122.34(f)(3). This relief from reporting is specified in Sec. 122.35(a).

Section 122.35 addresses the concerns of some commenters who sought relief for governmental facilities that are classified as small MS4s under today's rule. These facilities frequently discharge storm water through another regulated MS4 and could be regulated by that MS4's program. For example, a State owned office complex that operates its storm sewer system in an urbanized area will be regulated as an MS4 under today's rule even though its system may be subject to the storm water controls of the municipality in

[[Page 68768]]

which it is located. Today's rule specifically revised the definition of MS4 to recognize that different levels of government often operate MS4s and that each such separate entity (including the federal government) should be responsible for its discharges. If both MS4s agree, the downstream MS4 can develop a storm water management program that regulates the discharge from both MS4s. The upstream small MS4 operator still must submit an NOI that identifies the entity on which the upstream small MS4 operator is relying to satisfy its permit obligations. No reports are required from the upstream small MS4 operator, but the upstream operator must remain in compliance with the downstream MS4 operator's storm water management program. This option allows small MS4s to work together to develop one storm water management program that satisfies the permit obligations of both. If they cannot agree, the upstream small MS4 operator must develop its own program.

As mentioned previously, comments from federal facilities and State organizations that operate MS4s requested that their permit requirements differ from those of MS4s that are political subdivisions of States (cities, towns, counties, etc.). EPA acknowledges that there are differences; e.g., many federal and State facilities do not serve a resident population and thus might require a different approach to public education. EPA believes, however, that MS4s owned by State and federal governments can develop storm water management plans that address the minimum measures. Federal and State owned small MS4s may choose to work with adjacent municipally owned MS4s to develop a unified plan that addresses all of the required measures within the jurisdiction of all of the contiguous MS4s. The options in Sec. 122.35 minimize the burden on small MS4s that are covered by another MS4's program.

One commenter recommended that if one MS4 discharges into a second MS4, the operator of the upstream MS4 should have to provide a copy of its NOI or permit application to the operator of the receiving MS4. EPA did not adopt this recommendation because the NOI and permit application will be publicly available; but EPA does recommend that NPDES permitting authorities consider it as a possible permit requirement. The commenter also suggested that monitoring data should be collected by the upstream MS4 and provided to the downstream MS4. EPA is not adopting such a uniform monitoring requirement because EPA believes it is more appropriate to let the MS4 operators work out the need for such data. If necessary, the downstream MS4s might want to make such data a condition to allowing the upstream MS4 to connect to its system.

v. Joint Permit Programs. Many commenters supported allowing the operators of small MS4s to apply as co-permittees so they each would not have to develop their own storm water management program. Today's rule specifically allows regulated small MS4s to join with either other small MS4s regulated under Sec. 122.34(d) or with medium and large MS4s regulated under Sec. 122.26(d).

As is discussed in the previous section, regulated small MS4s may indicate in their NOIs that another entity is performing one or more of its required minimum control measures. Today's rule under Sec. 122.33(b)(1) also specifically allows the operators of regulated small MS4s to jointly submit an NOI. The joint NOI must clearly indicate which entity is required to implement which control measure in each geographic jurisdiction within the service area of the entire small MS4. The operator of each regulated small MS4 remains responsible for the implementation of each minimum measure for its MS4 (unless, as is discussed in the previous section above, the permit recognizes that another entity is responsible for completing the measure.) The joint NOI, therefore, is legally equivalent to each entity submitting its own NOI. EPA is, however, revising the rule language to specifically authorize the joint submission of NOIs in response to comments that suggested that such explicit authorization might encourage programs to be coordinated on a watershed basis.

Section 122.33(b)(2)(iii) authorizes regulated small MS4s to jointly apply for an individual permit to implement today's rule, where allowed by an NPDES permitting authority. The permit application should contain sufficient information to allow the permitting authority to allocate responsibility among the parties under one of the two permitting options in Secs. 122.33(b)(2)(i) and (ii).

Section 122.33(b)(3) of today's rule also allows an operator of a regulated small MS4 to join as a co-permittee in an existing NPDES permit issued to an adjoining medium or large MS4 or source designated under the existing storm water program. This co-permittee option applies only with the agreement of all co-permittees. Under this co-permittee arrangement, the operator of the regulated small MS4 must comply with the terms and conditions of the applicable permit rather than the permit condition requirements of Sec. 122.34 of today's rule. The regulated small MS4 that wishes to be a co-permittee must comply with the applicable requirements of Sec. 122.26(d), but would not be required to fulfill all the permit application requirements applicable to medium and large MS4s. Specifically, the regulated small MS4 is not required to comply with the application requirements of Sec. 122.26(d)(1)(iii) (Part 1 source identification), Sec. 122.26 (d)(1)(iv) (Part 1 discharge characterization), and Sec. 122.26(d)(2)(iii) (Part 2 discharge characterization data). Furthermore, the regulated small MS4 operator would satisfy the requirements in Sec. 122.26(d)(1)(v) (Part 1 management programs) and Sec. 122.26(d)(2)(iv) (Part 2 proposed management program) by referring to the adjoining MS4 operator's existing plan. An operator pursuing this option must describe in the permit modification request how the adjoining MS4's storm water program addresses or needs to be supplemented in order to adequately address discharges from the MS4. The request must also explain the role of the small MS4 operator in coordinating local storm water activities and describe the resources available to accomplish the storm water management plan.

EPA sought comments regarding the appropriateness of the application requirements in these subsections of Sec. 122.26(d). One commenter stated that newly regulated smaller MS4s should not be required to meet the existing regulations' Part II application requirements under Sec. 122.26(d) regarding the control of storm water discharges from industrial activity. EPA disagrees. The smaller MS4 operators designated for regulation in today's rule may satisfy this requirement by referencing the legal authority of the already regulated MS4 program to the extent the newly regulated MS4 will rely on such legal authority to satisfy its permit requirements. If the smaller MS4 operator plans to rely on its own legal authorities, it must identify it in the application. If the smaller MS4 operator does not elect to use its own legal authority, they may file an individual permit application for an alternate program under Sec. 122.33(b)(2)(ii).

The explanatory language in Sec. 122.33(b)(3) recommends that the smaller MS4s designated under today's rule identify how an existing plan ``would need to be supplemented in order to adequately address your discharges.'' One commenter suggested that this must be regulatory language and not guidance. EPA disagrees that this needs to be mandatory language.

[[Page 68769]]

Since many of the smaller MS4s designated today are ``donut holes'' within the geographic jurisdiction of an already regulated MS4, the larger MS4's program generally will be adequate to address the newly regulated MS4's discharges. The small MS4 applicant should consider the adequacy of the existing MS4's program to address the smaller MS4's water quality needs, but EPA is not imposing specific requirements. Where circumstances suggest that the existing program is inadequate with respect to the newly designated MS4 and the applicant does not address the issue, the NPDES permitting authority must require that the existing program be supplemented.

Commenters recommended that the application deadline for smaller MS4s designated today be extended so that existing regulated MS4s would not have to modify their permit in the middle of their permit term, provided that permit renewal would occur within a reasonable time (12 to 18 months) of the deadline. In response, EPA notes that today's rule allows operators of newly designated small MS4s up to three years and 90 days from the promulgation of today's rule to submit an application to be covered under the permit issued to an already regulated MS4. The permitting authority has a reasonable time after receipt of the application to modify the existing permit to include the newly designated source. If an existing MS4's permit is up for renewal in the near future, the operator of a newly designated small MS4 may take that into account when timing its application and the NPDES permitting authority may take that into account when processing the application.

Another commenter suggested that the rule should include a provision to allow permit application requirements for smaller MS4s designated today to be determined by the permitting authority to account for the particular needs/wants of an already regulated MS4 operator. EPA does not believe that the regulations should specifically require this approach. When negotiating whether to include a newly designated MS4 in its program, the already regulated MS4 operator may require the newly designated MS4's operator to provide any information that is necessary.

The co-permitting approach allows small MS4s to take advantage of existing programs to ease the burden of creating their own programs. The operators of regulated small MS4s, however, may find it simpler to apply for a program under today's rule, and to identify the medium or large MS4 operator that is implementing portions of its Sec. 122.34(b) minimum measures.

d. Evaluation and Assessment

Under today's rule, operators of regulated small MS4s are required to evaluate the appropriateness of their identified BMPs and progress toward achieving their identified measurable goals. The purpose of this evaluation is to determine whether or not the MS4 is meeting the requirements of the minimum control measures. The NPDES permitting authority is responsible for determining whether and what types of monitoring needs to be conducted and may require monitoring in accordance with State/Tribe monitoring plans appropriate to the watershed. EPA does not encourage requirements for ``end-of-pipe'' monitoring for regulated small MS4s. Rather, EPA encourages permitting authorities to carefully examine existing ambient water quality and assess data needs. Permitting authorities should consider a combination of physical, chemical, and biological monitoring or the use of other environmental indicators such as exceedance frequencies of water quality standards, impacted dry weather flows, and increased flooding frequency. (Claytor, R. and W. Brown. 1996. Environmental Indicators to Assess Storm Water Control Programs and Practices. Center for Watershed Protection, Silver Spring, MD.) Section II.L., Water Quality Issues, discusses monitoring in greater detail.

As recommended by the Intergovernmental Task Force on Monitoring Water Quality (ITFM), the NPDES permitting authority is encouraged to consider the following watershed objectives in determining monitoring requirements: (1) To characterize water quality and ecosystem health in a watershed over time, (2) to determine causes of existing and future water quality and ecosystem health problems in a watershed and develop a watershed management program, (3) to assess progress of watershed management program or effectiveness of pollution prevention and control practices, and (4) to support documentation of compliance with permit conditions and/or water quality standards. With these objectives in mind, the Agency encourages participation in group monitoring programs that can take advantage of existing monitoring programs undertaken by a variety of governmental and nongovernental entities. Many States may already have a monitoring program in effect on a watershed basis. The ITFM report is included in the docket for today's rule (Intergovernmental Task Force on Monitoring Water Quality. 1995. The Strategy for Improving Water-Quality Monitoring in the United States: Final Report of the Intergovernmental Task Force on Monitoring Water

Quality. Copies can be obtained from: U.S. Geological Survey, Reston, VA.).

EPA expects that many types of entities will have a role in supporting group monitoring activities--including federal agencies, State agencies, the public, and various classes or categories of point source dischargers. Some regulated small MS4s might be required to contribute to such monitoring efforts. EPA expects, however, that their participation in monitoring activities will be relatively limited. For purposes of today's rule, EPA recommends that, in general, NPDES permits for small MS4s should not require the conduct of any additional monitoring beyond monitoring that the small MS4 may be already performing. In the second and subsequent permit terms, EPA expects that some limited ambient monitoring might be appropriately required for perhaps half of the regulated small MS4s. EPA expects that such monitoring will only be done in identified locations for relatively few pollutants of concern. EPA does not anticipate ``end-of-pipe'' monitoring requirements for regulated small MS4s.

EPA received a wide range of comments on this section of the rule. Some commenters believe that EPA should require monitoring; others want a strong statement that the newly regulated small MS4s should not be required to monitor. Many commenters raised questions about exactly what EPA expects MS4s to do to evaluate and assess their BMPs. EPA has intentionally written today's rule to provide flexibility to both MS4s and permitting authorities regarding appropriate evaluation and assessment. Permitting authorities can specify monitoring or other means of evaluation when writing permits. If additional requirements are not specified, MS4s can decide what they believe is the most appropriate way to evaluate their storm water management program. As mentioned above, EPA expects that the necessity for monitoring and its extent may change from permit cycle to permit cycle. This is another reason for making the evaluation and assessment rule requirements very flexible.

i. Recordkeeping. The NPDES permitting authority is required to include at least the minimum appropriate recordkeeping conditions in each permit. Additionally, the NPDES permitting authority can specify that permittees develop, maintain, and/or

[[Page 68770]]

submit other records to determine compliance with permit conditions. The MS4 operator must keep these records for at least 3 years but is not required to submit records to the NPDES permitting authority unless specifically directed to do so. The MS4 operator must make the records, including the storm water management program, available to the public at reasonable times during regular business hours (see 40 CFR 122.7 for confidentiality provision). The MS4 operator is also able to assess a reasonable charge for copying and to establish advance notice requirements for members of the public.

EPA received a comment that questioned EPA's authority to require MS4s to make their records available to the public. EPA disagrees with the commenter and believes that the CWA does give EPA the authority to require that MS4 records be available. It is also more practical for the public to request records directly from the MS4 than to request them from EPA who would then make the request to the MS4. Based on comments, EPA revised the proposed rule so as not to limit the time for advance notice requirements to 2 business days.

ii. Reporting. Under today's rule, the operator of a regulated small MS4 is required to submit annual reports to the NPDES permitting authority for the first permit term. For subsequent permit terms, the MS4 operator must submit reports in years 2 and 4 unless the NPDES permitting authority requires more frequent reports. EPA received several comments supporting this timing for report submittal. Other commenters suggested that annual reports during the first permit cycle are too burdensome and not necessary. EPA believes that annual reports are needed during the first 5-year permit term to help permitting authorities track and assess the development of MS4 programs, which should be established by the end of the initial term. Information contained in these reports can also be used to respond to public inquiries.

The report must include (1) the status of compliance with permit conditions, an assessment of the appropriateness of identified BMPs and progress toward achieving measurable goals for each of the minimum control measures, (2) results of information collected and analyzed, including monitoring data, if any, during the reporting period, (3) a summary of what storm water activities the permittee plans to undertake during the next reporting cycle, and (4) a change in any identified measurable goal(s) that apply to the program elements.

The NPDES permitting authority is encouraged to provide a brief two-page reporting format to facilitate compiling and analyzing the data from submitted reports. EPA does not believe that submittal of a brief annual report of this nature is overly burdensome, and has not changed the required reporting time frame from the proposal. The permitting authority will use the reports in evaluating compliance with permit conditions and, where necessary, will modify the permit conditions to address changed conditions.

iii. Permit-As-A-Shield. Section 122.36 describes the scope of authorization (i.e. ``permit-as-a-shield'') under an NPDES permit as provided by section 402(k) of the CWA. Section 402(k) provides that compliance with an NPDES permit is deemed compliance, for purposes of enforcement under CWA sections 309 and 505, with CWA sections 301, 302, 306, 307, and 403, except for any standard imposed under section 307 for toxic pollutants injurious to human health.

EPA's Policy Statement on Scope of Discharge Authorization and Shield Associated with NPDES Permits, originally issued on July 1, 1994, and revised on April 11, 1995, provides additional information on this matter.

e. Other Applicable NPDES Requirements

Any NPDES permit issued to an operator of a regulated small MS4 must also include other applicable NPDES permit requirements and standard conditions, specifically the applicable requirements and conditions at 40 CFR 122.41 through 122.49. Reporting requirements for regulated small MS4s are governed by Sec. 122.34 and not the existing requirements for medium and large MS4s at Sec. 122.42(c). In addition, the NPDES permitting authority is encouraged to consult the Interim Permitting Approach, issued on August 1, 1996. The discussion on the Interim Permitting Approach in Section II.L.1, Water Quality Based Effluent Limits, provides more information. The provisions of Secs. 122.41 through 122.49 establish permit conditions and limitations that are broadly applicable to the entire range of NPDES permits. These provisions should be interpreted in a manner that is consistent with provisions that address specific classes or categories of discharges. For example, Sec. 122.44(d) is a general requirement that each NPDES permit shall include conditions to meet water quality standards. This requirement will be met by the specific approach outlined in today's rule for the implementation of BMPs. BMPs are the most appropriate form of effluent limitations to satisfy technology requirements and water quality-based requirements in MS4 permits (see the introduction to Section II.H.3, Municipal Permit Requirements, Section II.H.3.h, Reevaluation of Rule, and the discussion of the Interim Permitting Policy in Section II.L.1. below).

f. Enforceability

NPDES permits are federally enforceable. Violators may be subject to the enforcement actions and penalties described in CWA sections 309, 504, and 505 or under similar water pollution enforcement provisions of State, tribal or local law. Compliance with a permit issued pursuant to section 402 of the Clean Water Act is deemed compliance, for purposes of sections 309 and 505, with sections 301, 302, 306, 307, and 403 (except any standard imposed under section 307 for toxic pollutants injurious to human health).

g. Deadlines

Today's final rule includes expeditious deadlines as required by CWA section 402(p)(6). In proposed Sec. 122.26(e), the permit application for the ``ISTEA'' facilities was maintained as August 7, 2001 and the permit application deadline for storm water discharges associated with other construction activity was established as 3 years and 90 days from the final rule date. In proposed Sec. 122.33(c)(1), operators of regulated small MS4s were required to seek permit coverage within 3 years and 90 days from the date of publication of the final rule. In proposed Sec. 122.33(c)(2), operators of regulated small MS4s designated by the NPDES permitting authority on a local basis under Sec. 122.32(a)(2) must seek coverage under an NPDES permit within 60 days of notice, unless the NPDES permitting authority specifies a later date.

In order to increase the clarity of today's final rule, EPA has changed the location of some of the above requirements. All application deadlines for both Phase I and Phase II are now listed or referenced in Sec. 122.26(e). Section 122.26(e)(1) contains the deadlines for storm water associated with industrial activity. Paragraph (i) has been changed to correct a typographical error. Paragraph (ii) has been revised to reflect the changed application date for ``ISTEA'' facilities. (See discussion in section I.3, ISTEA Sources). The application deadline for storm water discharges associated with other construction activity is now in a new Sec. 122.26(e)(8). The application deadline for regulated small MS4s

[[Continued on page 68771]]